NINETEENTH REPORT OF THE ONTARIO BUREAU OF MINES: PART I.

1910

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NINETEENTH ANNUAL REPORT

OF THE

BUREAU OF MINES, 1910

VOL. XIX., PART I.

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LETTER OF TRANSMISSION

To His Honour John Morison Gibson, Etc., Etc., Etc.

Lieutenant-Governor of the Province of Ontario:

Sir,—I have the honour to transmit herewith for presentation to the Legislative Assembly of the Province of Ontario, the Nineteenth Annual Report of the Bureau of Mines.

I have the honour to be, Sir,
Your obedient servant,

F. Cochrane,
Minister of Lands, Forests and Mines.

Department of Lands, Forests and Mines,
Toronto, 10th March, 1910.

INTRODUCTORY LETTER

To The Honourable Frank Cochrane,
Minister of Lands, Forests and Mines:

Sir.—I beg to hand you herewith to be presented to His Honour the Lieutenant-Governor In Council, the Nineteenth Annual Report of the Bureau of Mines.

The Report is in two Parts.

Part I. contains a Statistical Review of the mining industry of Ontario for the year 1909, including tables showing the quantity and value of the output of the various minerals and mineral substances which are the products of that industry. The growth and progress of the several branches of mining and metallurgy during the year are briefly described, and particulars given as to the developments which are taking place. Generally speaking, it may be said that the record of 1909 is the best yet. The aggregate valne of the production is much greater than that of any previous year, and this is in face of the fact that prices for some of the most important products have remained stationary, or have even declined. The results so far obtained from the exploitation of Ontario's mineral resources warrant us in believing that in no part of Canada is there greater metalliferous wealth than is contained in the Pre-Cambrian rocks of the northern and eastern parts of this Province. In silver, Ontario's production is third in quantity among the silver-producing communities, being surpassed only by Mexico and the United States. Her nickel mines now supply most of the nickel used throughout the world. In some products of minor yet of considerable importance Ontario takes high rank. Among these are: Cobalt, arsenic, corundum and mica, sharing with Quebec her position with regard to the last-named. Other departments of the mineral industry continue to grow in output; natural gas, iron pyrites, feldspar, Portland cement. There is no reason apparent why Ontario should not continue to make good her claim to the premier place in the mining industry among the confederated Provinces of Canada.

Details regarding the revenue derived from mining sources are given in Part I. There is also presented a paper on Mining Accidents, in which Mr. E. T. Corkill, Inspector of Mines, analyzes the casualties occurring in the mines of Ontario with reference to their causes and the steps which may be taken looking to the reduction of their number, which compares unfavorably with many other countries.

Mr. Corkill reports as well upon the operating mines of Ontario, giving details of work done during the year; also upon water powers made use of for working mines. This source of energy is abundant in the mining districts and is exercising a very favorable influence upon their development.

A brief paper by Mr. G. R. Mickle, Mine Assessor, on the Kent Gas Field, shows the importance of natural gas to the people of a portion of the southwestern peninsula of Ontario, and the part this cheap and efficient fuel plays in the domestic and industrial life of the community.

The basic importance of the iron industry and the certainty that the diminution now going on in the known supplies of first-class iron ore on this continent must sooner or later bring into use deposits of ore now regarded as of little value because of the impurities which they contain, has led the Bureau to investigate the question of how far the low grade magnetites of Ontario are amenable to improvement by known processes of concentration. Experiments were carried on by Mr. George C. MacKenzie on ores from typical Ontario deposits, varying in chemical composition and physical structure, and the results obtained are described by Mr. MacKenzie in his paper on Concentration of Low Grade Magnetites.

In the summer of 1909 Dr. E. S. Moore explored the Iron formations of Lake Savant and his report thereon will be found under the title of Lake Savant Iron Range Area.

A paper on the Nepheline Syenites of Port Coldwell, by Mr. H. L. Kerr, describes these interesting rocks, and indicates the possibility of obtaining from the north shore of Lake Superior material equal to certain Norwegian granites, highly esteemed for monnmental and structural purposes.

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Accompanying Part I. are geologically colored maps of (1) Lake Savant Iron Range Area, (2) Port Coldwell Region, and (3) Porcupine Gold Area, together with an etching showing the profile of that part of Ontario stretching from Toronto to the boundary between the Archean and Paleozoic formations, north of the height of land.

Part II., which will be issued later in the year, will be a revision of Professor W. G. Miller's Report on the Silver Regions of Northern Ontario, including Cobalt, South Lorrain, Montreal River and Gowganda. This will be the fourth edition, and will be accompanied by separate maps of the Cobalt and Gowganda regions. Both will be geologically colored, and on a scale of one mile to the inch.

I have the honour to be, Sir,

Your obedient servant,

THOS. W. GIBSON,
Deputy Minister of Mines

DEPARTMENT OF LANDS, FORESTS AND MINES,
Toronto, 10th March, 1910.

REPORT OF
THE BUREAU OF MINES
1910

VOL. XIX PART I

STATISTICAL REVIEW

By Thos. W. Gibson, Deputy Minister of Mines.

The output of the mines and mineral works of Ontario for the year 1909, according to returns made to the Bureau of Mines under the provisions of the Mining Act of Ontario, had a value of $32,981,375, as shown in the table of production below (Table I.).

As compared with the output of 1908, previously the largest on record, the increase was 28 per cent. The rapidly growing importance of the mineral industry is sufficiently attested by these figures, especially when it is borne in mind that the value of the products is computed on their selling prices at the mines or other places of production. Calculating the metallic products only on the basis of "refined values," namely, the market prices of the refined metals, the valuation of the entire production is upwards of 37 million dollars, or about 41 per cent. of the total output of the Dominion of Canada for the year. (See Table III.)

Formerly, the non-metallic products surpassed those of a metallic kind in value of production. In 1905, for the first time, the metalliferous substances took the lead, and each year since then the difference has increased, until in 1909 the proportion of the whole furnished by the metals was 70 per cent. Both classes of products show substantial gains, the value of the metals as compared with 1908 having increased 37 per cent., and of the non-metals 13 per cent.

Silver is the chief item of increase, the value being $3,327,892, or 36 per cent.; next comes pig iron, increase $1,910,689, or 43 per cent.; then nickel $924,739, or 49 per cent. Iron ore is greater by $70,783, copper by $55,875, and zinc ore by $8,950. Gold is less by $27,892, and cobalt by $16,153. Of the non-metallic products, Portland cement shows an increase of $479,579, or 20 per cent., and natural gas $199,563, or 20 per cent. Bricks of all kinds are greater in value by $357,170, or 17 per cent., drain tile by $24,892, and lime by $22,262. On the other hand, petroleum shows a decrease of $144,295, or 26 per cent., salt of $98,757, stone of $70,311, and sewer pipe of $32,430. Further comment upon these and other fluctuations in production will be made when dealing with the several products in detail.

Of the aggregate production the larger items contributed the following percentages: Silver 38, pig iron 19, nickel 8, copper 3.4, Portland cement 8.8, bricks 7.5, natural gas 3.6, petroleum 1.7. These products account for about 90 per cent. of the total production, the remaining 10 per cent. being contributed by 22 other articles of smaller output.

In Table I. is given a summary of the mineral production for 1909, together with the number of employees engaged in the mines or works by which the various articles were produced, and the amounts paid them as wages. It should, perhaps, be stated, in order to prevent misunderstanding, that these statistics deal with producing mines and plants only, and take little or no account either as regards employees or wages of those

prospects, mines or works which have not yet reached the stage of actual production. There are many properties upon which more or less work has been done, but which cannot properly be classed as mines or related in any way to a table of mineral production. Among these, for instance, is the large number of unpatented mining claims upon which, in order to comply with the provisions of the Mining Act, 30 to 90 days' work is done within the year. To class the prospectors or laborers who do this work as working miners or employees engaged in producing minerals, would be misleading. There are also those openings, further advanced than mere prospects, yet not entitled to be designated mines, whose owners carry on work in them from time to time as they happen to be in funds for doing so, perhaps for a few weeks or months in one year, and then not at all perhaps for several years. Not many properties in this Province give regular employment to any considerable amount of labor which are not at the same time producing mineral. In almost every branch of the mining industry the period necessarily elapsing between the beginning of serious work and the proving of the property is comparatively short. If the attempt to make a mine succeeds, the raising of ore begins; if it fails, work ceases either permanently or for the time being. For these reasons, therefore, only the labor engaged in winning minerals or turning out mineral products, as the case may be, or in operating mines properly so called, is comprehended in the table of production annually given in the Bureau's reports.

Table I.—Mineral Production of Ontario, 1909

Product.	Quantity.	Value.	Employees.	Wages.
Metallic :		$		$
Gold.....ounces	2,042	32,445	100	68,206
Silver ..... "	25,903,985	12,464,722	3,251	2,605,128
Cobalt.....tons	1,533	94,965		
Nickel..... "	13,907	2,790,798	1,796	1,276,091
Copper..... "	7,933	1,127,015		
Iron ore ..... "	263,777	645,622	391	230,446
Pig iron..... "	407,013	6,301,528	2,231(a)	1,379,308(a)
Zinc ore..... "	895	8,950	20	7,700
	.....	23,466,045	7,779	5,566,879
Less value Ontario iron ore (220,307 tons) smelted into pig iron.....	.....	537,549	.....	.....
Net metallic production.....	.....	22,928,496	7,779	5,566,879
Non-metallic :				
Arsenic, refined.....tons	1,085	61,039	(b)	(b)
" crude..... "	3,218	.....	.....	.....
Brick, common.....No.	246,308,000	1,916,147	3,166	961,881
Tile, drain ..... "	27,418,000	363,550		
Brick, pressed..... "	53,166,941	490,571	488	254,950
" paving ..... "	4,067,620	73,700		
Building and crushed stone	.....	660,000	944	357,821
Calcium carbide .....tons	2,349	151,676	60	39,580
Cement, Portland ..... "	2,303,263	2,897,348	1,354	631,137
Corundum, grain..... "	1,508	140,817	165	96,168
Feldspar..... "	11,001	36,204	53	14,858
Graphite, refined..... "	730	37,624	117	34,193
Gypsum, crude ..... "	11,488	23,604	41	3,500
Iron pyrites ..... "	28,946	78,170	132	104,637
Lime .....bush.	2,633,500	470,858	438	173,905
Mica .....tons	350	73,124	123	38,632
Natural gas.....	.....	1,188,179	171	103,672
Peat fuel.....tons	60	240	7	1,200
Petroleum .....Imp. gal.	14,723,105	559,478(c)	436(d)	261,014
Phosphate of lime.....tons	272	1,904	12	4,371
Pottery	.....	43,214	33	12,837
Quartz.....tons	63,172	75,329	111	46,906
Salt..... "	77,490	389,573	176	89,995
Sewer pipe	.....	311,830	200	96,815
Talc .....tons	4,350	8,700	12	3,316
	.....	10,052,879	8,239	3,331,388
Add metallic production	.....	22,928,496	7,779	5,566,879
Total production.....	.....	32,981,375	16,018	8,898,267
Total for 1908	.....	25,637,617	15,189	7,858,267

(a) Includes steel making. (b) Included in cobalt and silver. (c) Value crude, exclusive of Dominion government bounty. (d) Petroleum refineries only.

In the following table the changes in production for 1909 are shown, as compared with 1908:—

Table II.——Comparative Value Mineral Production, 1908 and 1909

Product.	1908.	1909.	Change. (I) Increase. (D) Decrease.	
Metallic:	$	$		$
Gold	60,337	32,445	D	27,892
Silver	9,136,830	12,464,722	I	3,327,892
Cobalt	111,118	94,965	D	16,153
Nickel	1,866,059	2,790,798	I	924,739
Copper	1,071,140	1,127,015	I	55,875
Iron ore	574,839	645,622	I	70,783
Pig iron	4,390,839	6,301,528	I	1,910,689
Zinc ore	....	8,950	I	8,950
Non-metallic:				
Arsenic	40,373	61,039	I	20,666
Brick, common	1,575,875	1,916,147	I	340,272
" pressed	485,819	490,571	I	4,752
" paving	61,554	73,700	I	12,146
Building and crushed stone	530,041	459,730	D	70,311
Calcium carbide	147,150	151,676	I	4,526
Cement, Portland	2,417,769	2,897,348	I	479,579
Corundum	11,437	140,817	I	129,380
Feldspar	20,300	36,204	I	15,904
Graphite	1,600	37,624	I	36,024
Gypsum	20,778	23,604	I	2,826
Iron pyrites	69,980	78,170	I	8,190
Lime	448,596	470,858	I	22,262
Mica	73,586	73,124	D	462
Natural gas	988,616	1,188,179	I	199,563
Peat fuel	900	240	D	660
Phosphate of lime	7,048	1,904	D	5,144
Petroleum	703,773	559,478	D	144,295
Pottery	50,310	43,214	D	7,096
Quartz	52,830	75,329	I	22,499
Salt	488,330	389,573	D	98,757
Sewer pipe	344,260	311,830	D	32,430
Talc	3,048	8,700	I	5,652
Tile, drain	338,658	363,550	I	24,892

Owing to the difference between the basis adopted for reporting the value of minerals and mineral products by the Bureau of Mines, and that employed by the Mines Department at Ottawa, and the consequent variation in the results obtained, the schedule of production (Table I.) is herewith presented with values and quantities of the metallic products recast in accordance with the Mines Department's methods. The effect is to permit an intelligent estimate to be made of the importance of Ontario's mineral industry, as compared with that of the remainder of Canada. Of a total production for 1909, reported by the Mines Department for the whole of the Dominion, it will be seen that Ontario contributed $37,352,124, or 41 per cent. In the metalliferous branches of mining, Ontario's pre-eminence is marked. The Mines Department values the total metallic production of Canada in 1909 at $45,188,387. Of this Ontario contributes $27,299,245, or 60 per cent. The merits of the respective methods of computation have been discussed in previous Reports, and need not be dealt with here.

Table III.—Value Mineral Production, 1909, "Mines Department" Basis

Product.		Quantity.	Price.	Value.
				$
Gold	oz.	2,042	$15.88 per oz.	32,445
Silver	"	25,903,985	51.503 cents per oz.	13,341,329
Cobalt	tons	1,533	$61.94 per ton	94,965
Nickel	"	13,141 (a)	36 cents per lb.	9,461,520
Copper	"	7,933	12.982 cents per lb.	2,059,724
Pig iron	"	117,389 (b)	$15.43 per ton	1,811,312
Zinc ore	"	895	$10 per ton	8,950
			Total	27,299,245
Value non-metallic production per Table I.				10,052,879
Gross value production				$37,352,124

(a) Contents Sudbury mattes only. (b) Proportion pig iron from Ontario ore.

Development of Mineral Industry

The progress of the mineral industry in this Province during the last five years is set forth in the following table. It will be seen that in 1909 the output had a money value nearly twice as great as that of four years ago.

Table IV.—Mineral Production, 1905 to 1909

Product.	1905.	1906.	1907.	1908.	1909.
Metallic:	$	$	$	$	$
Gold	99,885	66,193	66,399	60,337	32,445
Silver	1,372,877	3,689,286	6,157,871	9,136,830	12,464,722
Platinum.. } Palladium. }	28,116	5,652	....	....	....
Cobalt	100,000	80,704	92,751	111,118	94,965
Copper	688,993	960,813	1,045,511	1,071,140	1,127,015
Nickel	3,354,934	3,839,419	2,271,616	1,866,059	2,790,798
Iron ore	227,909	301,032	482,532	574,839	645,622
Pig iron	3,909,527	4,554,217	4,716,857	4,390,839	6,301,528
Steel	3,321,884	(a)	(a)	(a)	(a)
Pig lead	9,000	93,500	....	....	....
Zinc ore	....	6,000	....	....	8,950
	13,113,125	13,596,846	14,833,537	17,211,162	23,466,045
Less value Ontario iron ore smelted into pig iron, and pig iron converted into steel....	2,912,115	(b) 243,776	(b) 282,702	(b) 456,176	(b) 537,549
Net metallic production	10,201,010	13,353,080	14,550,835	16,754,986	22,928,496
Non-metallic:					
Actinolite	....	....	....	....	....
Arsenic	2,693	15,858	40,104	40,373	61,039
Brick, common	1,937,500	2,157,000	2,109,978	1,575,875	1,916,147
" paving	54,000	45,000	73,270	61,554	73,700
" pressed	234,000	337,795	648,683	485,819	490,571
Building and crushed stone	700,000	660,000	675,000	530,041	660,000
Carbide of calcium	156,755	162,780	173,763	147,150	151,676
Cement, natural rock	10,402	6,000	5,097	....	....
" Portland	1,783,451	2,381,014	2,777,478	2,417,769	2,897,348
Corundum	152,464	262,148	242,608	11,437	140,817
Feldspar	29,968	43,849	30,375	20,300	36,204
Graphite	9,825	15,000	20,000	1,600	37,624
Gypsum	4,118	6,605	19,652	20,778	23,604
Iron pyrites	21,885	40,583	51,842	69,980	78,170
Lime	424,700	496,785	418,700	448,596	470,858
Mica	50,446	69,041	82,929	73,586	73,124
Natural gas	316,476	533,446	746,499	988,616	1,188,179
Peat fuel	1,200	900	1,040	900	240
Petroleum (crude)	898,545	761,546	1,049,631	703,773	559,478
Phosphate of lime	....	....	....	7,048	1,904
Pottery	60,000	65,000	54,585	50,310	43,214
Quartz	....	65,756	124,148	52,830	75,329
Salt	356,783	367,738	432,936	488,330	389,573
Sewer pipe	225,835	279,620	435,088	344,260	311,830
Sodalite	....	6,000	....	....	....
Talc	2,240	3,030	5,010	2,048	8,700
Tile, drain	220,000	252,500	250,122	338,658	363,550
Total non-metallic production	7,653,286	9,035,303	10,468,538	8,882,631	10,052,879
Add metallic production	10,201,010	13,353,080	14,550,835	16,754,986	22,928,496
Total production	17,854,296	22,388,383	25,019,373	25,637,617	32,981,375

(a) Steel production not included. (b) Iron ore only.

In the table which follows, the entire production of metals in Ontario is given to the end of 1909. Before the establishment of the Bureau of Mines in 1891 there was no provision for the systematic collection of statistics pertaining to the mining industry, and in consequence it is not possible now to do more than estimate the production previous to that year on the basis of such fragmentary information as can at this date be found. The output of every one of the metals since 1891, however, with the possible exception of lead, has been on a much larger scale than before, and any errors in the figures for the pre-Bureau period cannot materially affect the general accuracy of the table. The valuation of the several products, except where otherwise stated, is their selling prices at the places of production and in the form produced.

Table V.—Total Production of Metals in Ontario

Product.		Quantity.	Value.
			$
Gold	oz.	159,717	2,509,492
Silver (a)	"	68,221,494	48,069,154
Platinum and Palladium (b)	"	3,364	62,784
Cobalt (c)	tons	4,015	530,771
Nickel (d)	"	99,384	28,605,868
Copper (e)	"	89,458	13,000,000
Iron ore (f)	"	2,950,000	5,525,850
Pig iron (g)	"	2,208,754	34,500,000
Lead ore (h)	"	3,351	20,000
Pig lead	"	1,143	96,000
Zinc ore	"	7,128	86,650

(a) For estimated production previous to Cobalt see Bur. Mines, vol. 19, pp. 11, 12.

(b) 536 oz. platinum and 952 oz. palladium in 1904. In 1905 and 1906 these metals were reported together. No production has been returned since the latter year. The sole source is the nickel-copper mattes of Sudbury, from which they are recovered during the process of refining.

(c) Partly estimated, since the cobalt contents of ore shipments from the Cobalt silver mines are for the greater part not paid for, and no assays are reported to the shippers; 30 3-4 tons were obtained from the Sudbury nickel-copper mattes in 1892-4; remainder is from the ores of the Cobalt mines

(d) From mines of the Cobalt district, partly estimated, as in the case of cobalt, 1,997 tons; remainder from Sudbury mines.

(e) From the Sudbury mines 76,042 tons. Practically the only copper produced in Ontario before the opening of the Sudbury deposits was from the Bruce, Wellington and Huron Copper Bay mines on the north shore of Lake Huron. The total output of this group of locations from 1846, when they were opened, down to 1875, the date of their closing, is placed by Mr. H. J. Carnegie Williams, manager of Bruce mines in 1907, at 9,653 tons. (See paper on The Bruce Mines, Ontario, 1846-1906, Journal Canadian Mining Institute, vol. X, 1907.) The value of the production Mr. Williams gives at $3,300,000, as does also the report of the Royal Commission on the Mineral Resources of Ontario, 1890, p. 23. From sources other than Sudbury, mainly deposits on the north shore of Lake Huron, 3,773 tons were obtained since 1900.

(f) Statistics of production previous to 1869 are not now obtainable, but have been estimated at 300,000 tons; this, however, is in the nature of a guess, although made after consulting the available data. Previous inquirers have likewise failed to find authoritative figures. Most of the ore raised before 1869 (when the figures for the Provinces are first given separately in the Dominion Government tables) was exported to the United States.

(g) Estimated early production 40,000 tons; remainder since 1896.

(h) More or less lead ore was raised at various places, such as the Frontenac mine in Loughborough township; Victoria and Cascade mines near Garden River; Enterprise mine in McTavish township, also in Ramsay township, at intervals from 1865 to 1880, but there are no available statistics for this production, and it is not included above. The quantity, however, could not have been great.

Gold

The gold production of 1909 was confined almost entirely to one mine—the well-known Laurentian, in the Manitou Lake region, owned by Imperial Gold Mines, Limited. The amount of bullion recovered, 2,042 ounces, is the smallest reported for any year since 1894. Nothing was being done in the once-busy fields of Lake-of-the-Woods, Seine River, Sturgeon Lake, or Eastern Ontario, and Larder Lake is not turning out any gold.

It is not easy to assign a satisfactory cause for this lack of interest in the gold regions of the Province, but it may be that the attention of prospectors and capitalists alike has for the time being been absorbed by the phenomenal riches of the silver mines of Cobalt and surrounding regions.

Discoveries at Porcupine

The search for silver may, indeed, bring about a revival of gold mining. Prospectors looking for extensions of Cobalt last summer found in the townships of Whitney and Tisdale, near Porcupine Lake, a number of quartz veins of good dimensions, some of which contained considerable free gold on the surface. Mr. John S. Wilson, formerly of Massey Station, Ontario, was one of the earliest discoverers, if not the earliest, and a large outcropping of quartz with spectacular showings of gold has come to be known as "Wilson's dome." It is in places upwards of 100 feet wide. Other smaller veins, also carrying free gold, were located by Miller, Hollinger, Bannerman and others. The news of these finds caused a rush to the neighborhood, and much winter staking of claims took place. Development by shaft sinking has been carried on during the winter months, and if the veins prove to be rich at depth Porcupine gold camp may be the legitimate successor of Cobalt.

The new gold field includes the two townships mentioned and unsurveyed territory to the south, some of which is within the boundaries of the Temagami Forest Reserve. It is reached by winter road from Matheson station on the Temiskaming and Northern Ontario railway, via Night Hawk lake, and also from mile post 222. The summer route is from the latter point by way of Frederick House river and lake, Night Hawk lake, and Porcupine river. For the convenience of prospectors and to permit of mining claims being recorded on the ground instead of at Haileybury or Sudbury, both many miles away, a new Mining Division was established, called Porcupine Mining Division, Mr. Arthur E. D. Bruce, formerly of the Haileybury office, being appointed Recorder, with headquarters at Porcupine townsite, which has been laid out at the eastern extremity of Porcupine lake, on the south half of lot 9 in the fourth concession of Whitney. The date of the Order in Council creating the Division is January 27th, 1910.

Early Explorations of Porcupine Region

In 1896 Mr. E. M. Burwash described the rocks on the east boundary of the township of Shaw, which was at that time mile posts 114 to 120 on the boundary between the districts of Nipissing and Algoma. In Mr. Burwash's report, published in volume 6 of the Reports of the Bureau of Mines, he points out that the district gives promise as a gold field.

The territory in the neighborhood of Porcupine lake and river was explored for the Bureau of Mines by Dr. William A. Parks, of Toronto University, in 1898, who briefly describes the geology of the rock outcrops in the Bureau's Report, 1899 (vol. 8, pp. 175-177). Much of the region was covered by soil and swamp, but the presence of quartz seams in schist was noted. On assay a sample from one of these gave "a minute trace of gold." Again, in 1899, Dr. Parks, reporting on the geology of the tract adjacent to the northerly extension of the line ran in 1898, directs attention to the occurrence of highly silicious schists, both of the hard and softer varieties, the latter being, as he states, more favorable for gold, and hence being particularly mentioned by him in his report. Dr. Parks adds:[1]

> Gold seems to be well distributed over the region; in fact it may be said to occur in nearly all the Huronian belts, but generally in extremely small quantities. The richest specimen was obtained near the Pigeon Rapid on the Mattagami river; and I regard the region south of the trail to Porcupine lake as giving promise of reward to the prospector. The south arm of Matagaming lake and the river above show traces of gold, and a prospect might prove successful in that region.

Perhaps it is no part of a geologist's quest when engaged in determining the geology of an unknown area to search for actual deposits or veins of mineral, nor as a rule has he time or opportunity to do so; but in closely observing and clearly describing the rock formations and such indications of mineral as meet his view, he can sometimes blaze the path for the prospector following in his wake who is sufficiently intelligent to appreciate and make use of the information provided for him. Ten years is not a long time in the history of a Province. Two years ago the Temiskaming and Northern Ontario railway made accessible the region through which it was constructed, and the "promise of reward" south of the Porcupine trail spoken of by Dr. Parks in 1899 was claimed by John S. Wilson in 1909.

Further particulars regarding the townships of Whitney and Tisdale and the Porcupine area generally, including soil, timber, water powers and geology, will be found in the following Reports of the Bureau of Mines: Vol. xiii. (1904), The Abitibi Region, by George F. Kay and Tennyson D. Jarvis, pp. 104-134; and vol. xiv. (1905), Explorations in Abitibi, by James G. McMillan and Archibald Henderson, pp. 184-245; also in vol. xv. (1906), Exploration in Mattagami Valley, by H. L. Kerr and Archibald Henderson, pp. 116-155.

Report by James Bartlett

In October, 1909, Mr. James Bartlett, one of the Bureau's geologists, made a brief examination of the discoveries made up to that time, and reported upon them and on the formations in which they occur. Like previous observers, Mr. Bartlett found very

[1] Rep. Bur. Min., 1900, vol. 9, p. 141.

much of the country drift-covered, comparatively little being rock. His description is as follows:—

Whitney and Tisdale townships are reached from the T. & N.O. Ry., by leaving the train at mileage 228½, which point has been made a flag-station, and named "Red Pine Lakes." The canoe route from here to Porcupine lake, which is situated conveniently to the gold-bearing area, is estimated to be in the neighborhood of sixty miles in length, and is for the most part easy travelling. A fifty-chain portage leads from the railway to a small lake, from the south end of which a crooked creek drains into the Frederick House river. The latter stream is ascended through the lake of the same name to Night Hawk lake, and the remainder of the journey is via Porcupine river to Porcupine lake. Two portages—one of three chains and one of eight chains—occur on the Porcupine.

John S. Wilson, Discoverer of the Dome Mines, Porcupine.

Eight days were spent in this vicinity, and all the reported discoveries of gold were visited.

The area to the north and west of Porcupine lake is a low-lying one, consisting of a level plain, largely swamp-covered, with occasional outcrops of rock. The latter seldom rise to a height of more than ten or twenty feet—as a rule being only four or five feet above the surrounding plain. The rocks of this area strike in a northeasterly direction, and commonly weather with what might be described as a saw-tooth effect caused by the development of two planes of weakness, the one dipping at a high angle to the northwest, and the other at a much lower angle to the southwest. The rocks are much altered and some of the veins occur in a rock which approached a quartz-schist. Besides this type, rocks of a basic and others of a calcareous type occur.

In concessions 1 and 2, especially towards the more southerly part, the country is higher and more rock is exposed, but only a few cases were seen where the hills rise as high as forty feet. In this section the schistosity is much more marked than in the northern area—chlorite and hornblende schists being developed. One outcrop was found of a massive rock, which from the development of serpentine would lead one to suspect that it may have originated from an olivine-bearing rock.

The claims on which gold was seen are as follows:—

N.W. ¼ S. ½ Lot 1, Con. 5, Tisdale—Robert Bruce.

This discovery consists of a series of parallel veins of milky quartz, striking S. 83 degrees E., and varying in width from one to eighteen inches. These had been stripped for about twenty-five feet, and at one point on the contact of one of the veins with the country rock gold is visible in grains and in leaf-like forms.

N.E. ¼ S. ½ Lot 2, Con. 5, Tisdale—W. H. Reamsbottom.

A few specks of gold are to be seen in two irregular bands of quartz from two to three inches wide and dipping to the south at a low angle (almost horizontal).

S.W. ¼ S. ½ Lot 11, Con. 5, Whitney—A. E. Way (known as the "Bannerman" claim).

A vein of quartz on this property has been stripped at intervals for about three chains; strike east and west. Near the western end of the trenching it is about two feet wide, but about one chain to the east it is broken up into five parallel bands from three to twelve inches in width, separated by about six inches of country rock. Dip is not determinable. Gold is visible in two places on this vein.

S.W. ¼ S. ½ Lot 2, Con. 5, Tisdale—W. H. Davidson.

Gold has been found at several points on a vein striking S. 85 degrees E., with a dip to the south. The rock is much disturbed here, and the vein, so far as could be seen with the small amount of stripping, consists of a series of irregular lenses of quartz.

N.W. ¼ N. ½ Lot 4, Con. 1, Tisdale—F. C. Remington (locally known as the "Wilson" property).

The largest body of quartz seen in the district occurs on this property associated with a much decomposed green schist. This vein had been found only a few days before, so that no work had been done on it, but it could be traced for at least six chains in a southwesterly direction, and at one point it appeared to be two chains in width.

Gold could be seen at five or six different spots near the northern end of this outcrop, and one of these showings was the most attractive in the district. Enough gold not in the leaf form, but rather resembling nuggets, was scattered through the quartz in a space of about an inch and a half square to cover a twenty-five cent piece.

The quartz in this vein, as in all the others mentioned above, is of the milky variety and is practically free from sulphides. No sinking has been done on any of these properties and very little trenching. In view of this any estimates of "ore in sight" at the present time are unwarranted.

Since returning from the field another discovery has been reported in the southwestern part of Tisdale township.

It is the intention to have a more careful examination of the region made as soon as the snow leaves the ground in the spring of 1910, and a map dealing with the geology and mineralogy issued as soon as practicable. The map will cover the townships of Tisdale, Whitney, Shaw and Deloro, and will be ready for distribution the latter part of July or early in August. Discoveries of gold have also been made in the townships of Munro and Guibord, west of the T. & N. O. railway, and on one property a shaft 75 feet deep has been sunk.

The Mikado gold mine, situated on Shoal lake, west of Lake of the Woods, was in its day a large contributor to the gold output. Opened in 1896 on surface showings of unusual value, operations were continued until 1903, when the mine was closed down as having ceased to be remunerative. Up to the end of March, 1899, 18,464 tons of ore had been milled, yielding 9,575 ounces of gold worth at the mint $137,533.20, or an average of

$7.44 per ton of ore treated.[2] The Mikado has recently passed into the control of Captain H. A. Machin, M.P.P., and associates, who propose during 1910 to re-open and give the property a thorough trial in the belief that it yet contains a good deal of ore.

Sturgeon Lake Gold Field

For ten years or more gold has been known to exist on Sturgeon lake, some 40 miles or more north of Ignace station on the Canadian Pacific railway, and now within a few miles of the line of the Transcontinental railway. Several gold mines have been opened, one of which, the St. Anthony, has been operated with much persistency. Last year Dr. E. S. Moore, after completing the geological survey of the Lake Savant Iron Range area, spent a short time in the Sturgeon lake region. Dr. Moore writes:—

As very little of the field season remained it was found impossible to complete a survey of the area, and it was therefore deemed advisable to visit the region again in 1910, and to postpone a fuller report until the close of next season. The need for additional field work is due largely to the very poor map which exists of Couture lake and the northwestern part of Sturgeon lake, rendering it impracticable to pourtray the area correctly either topographically or geologically.

Open Cut, St. Anthony Mine, Sturgeon Lake.

During the time spent in the field it was found that gold was widely distributed over an area about 12 miles in length by 10 miles in maximum width. The whole gold-bearing area is in proximity to some of the numerous bays of Sturgeon lake. The most important portions lie in the vicinity of Couture lake and around Belmore, East and King's bays. The chief deposit is that of the St. Anthony mines on the shore of Couture lake.

The rocks are largely Keewatin in age, and form a very complex series, consisting of basaltic flows, rhyolites, quartz-porphyries, diorites, gabbros and green schists of indefinite origin. There are also some sediments, as arkoses and greywackés. Intruding this Keewatin series there is the Laurentian granite, which has greatly fractured and

[2] Rep. Bur. Min., vol. 8 (1899), p. 22.

brecciated the Keewatin, and has itself been broken and fissured around the contact. A portion of the granite is porphyritic, to which portion the ore deposits seem to be more or less closely related.

A small area of dolomite was seen, but its age is not certain. Abundant rock exposures make prospecting comparatively easy.

Although the gold-bearing veins seem to bear some relation to the porphyritic granite, it was found also that a number were associated with aplite dikes, which in some cases were near the granite contact, and in others some distance away. The vein matter is almost invariably quartz, generally milky or slightly opalescent, and very often mineralized. The minerals associated with the gold are pyrite, chalcopyrite, zinc blende, galena, pyrolusite and pyrrhotite. Some chromite was found on one of the claims in the vicinity of Belmore bay. On several claims considerable calcite occurs in the small veins and carries free gold. The greater portion of the gold is in the free state, though some of it is not free-milling and occurs with pyrite. The area is noted for the beautiful specimens of free gold which it has produced, and the St. Anthony mine especially has supplied some very fine nuggets.

The veins are generally irregular, as they follow along the contact between the Laurentian and Keewatin, or the cleavage planes of the Keewatin schists. They are in most cases true fissure veins. Their irregularity is due chiefly to the nature of the country rock, and in massive greenstone or quartz-porphyry the veins are usually more clear cut and continuous than in schist.

They have undergone secondary enrichment to some extent, as some of them carry much more free gold near the surface than at depth, and this enrichment seems to be due largely to the action of ferric sulphate.

Silver was reported by several of the prospectors, and an analysis of a promising sample from a claim on North bay of Sturgeon lake made by Mr. N. L. Turner, Provincial Assayer, at Belleville, showed 0.20 oz. gold ($4) and 22.72 oz. silver per ton ($11.36); total $15.36.

A large number of prospectors were at work in the area, and during the summer a considerable amount of development work was done in the shape of shaft-sinking and test-pitting. Although a large number of veins had been located, the majority of them cannot be regarded as of any importance, because of their diminutive size and very irregular form.

It is expected that with the completion of the field work during the coming summer a complete report accompanied by a satisfactory map of the Sturgeon lake gold fields will be published, and it is hoped that these will meet the needs of prospectors in this region.

Silver [3]

The output of silver last year was 25,903,985 ounces, yielding a return to the mining companies of $12,464,722. With the exception of a few thousand ounces produced by one of the mines west of Port Arthur, the entire product came from the mines of the Cobalt region. The advance in yield of these mines year by year has been remarkable, the total output since their opening in 1904 being 63,407,166 ounces. There were 32 producing mines, as follows:—Nipissing, Crown Reserve, La Rose group (including Lawson and University), Kerr Lake, O'Brien, McKinley-Darragh-Savage, Coniagas, Buffalo, Temiskaming and Hudson Bay (now Hudson Bay Limited), Right of Way, Trethewey, Temiskaming, City of Cobalt, Standard Cobalt (Cobalt Central), Chambers-Ferland, Wettlaufer-Lorrain, Beaver Consolidated, Silver Cliff, Nova Scotia, Cobalt Silver Queen, Drummond, King Edward, Cobalt Lake, Bailey, Nancy Helen, Casey Cobalt, Keeley, Foster, White Reserve, Hanson Consolidated. The last named is in the Port Arthur district.

Shipments from the mines comprised 27,742 tons of ore and 2,998 tons of concentrates, a total of 30,740 tons. The ore contained 22,437,595 ounces and the concentrates 3,466,390 ounces of silver, or an average tenor of 809 ounces per ton of ore and 1,165 ounces per ton of concentrates. The total production of concentrates was 3,448 tons from 129,072 tons of low grade ore or rock, the reduction thus being at the rate of 37.4 to 1.

[3] In a letter dated July 29th, 1910, at Heidelberg, Germany, Prof. Wm. Nicol of Kingston announces that he has recognized the mineral "stephanite" ($5\ Ag_2S \cdot Sb_2S_3$) in a specimen from Cobalt. This is the first identification of stephanite from the Cobalt deposits

Concentration of Low Grade Ores

Concentration of low grade material has now become an integral and important feature of mining practice at Cobalt, and is likely to undergo still further development. At the opening of the mines the surface ores were so rich that anything carrying less than 100 ounces per ton was lightly regarded, and was usually consigned to the dump. Now, however, as underground work proceeds, country rock adjoining the veins is frequently found to contain an appreciable proportion of silver, and this along with actual vein matter of low value constitutes the material which is sent to the crusher and concentration tables. At the close of 1909, seven of the mines were operating concentration mills, namely, Buffalo, Colonial, Coniagas, King Edward, McKinley-Darragh-Savage, Standard Cobalt and O'Brien. In addition to these, there were two custom concentrators, the Nipissing Reduction and Northern, at Cobalt, and one, the Montreal Reduction and Smelting Works, at Trout Mills near North Bay. At four other mines, the Nova Scotia, Silver Cliff, Temiskaming and Trethewey, concentration plants were under construction at the close of the year. The mills vary in capacity from 36 tons of ore per day at the King Edward to 150 tons at the Buffalo, with an aggregate of 850 tons, which will be increased to 1,250 tons when the plants now building begin to operate. Wet concentration methods are employed, supplemented at the Buffalo and O'Brien mines by cyanidation. At the Standard Cobalt concentrator a considerable quantity of ore was treated for near-by properties. At several of the mines small lots of metallic silver were smelted into base bullion.

Ore Purchasers and Refiners

Purchases of ore for smelters in the United States were last year as follows: American Smelting and Refining Company, New York; Balbach Smelting and Refining Company, Newark, New Jersey; Pennsylvania Smelting Company Pittsburg, Pa.; United States Metals Refining Company, New York. Ontario smelting companies were: Canadian Copper Company, Copper Cliff, Ont.; Coniagas Reduction Company, Thorold, Ont.; Deloro Mining and Reduction Company, Deloro, Ont. The works at Thorold ran mainly on the output of the Coniagas mine, those at Deloro on ore and concentrates from the O'Brien mine, and also on ores purchased from other mines, while the Canadian Copper Company bought high grade ore from sellers generally. Beer, Sondheimer and Company, of Frankfort-on-Main, Germany, bought some lots of high grade ore for shipment by way of New York, and Quirk, Barton and Company of London, England, obtained a small quantity of cobalt ore. The Canadian companies are the only buyers who pay anything for cobalt; Coniagas Reduction pays 8 cents per pound if cobalt contents are 6 per cent. or over, 10 cents per pound when they amount to 8 per cent. or over, and 12 cents when 10 per cent. or over; Deloro pays 10 cents per pound for 6 per cent. cobalt or over, Canadian Copper Company $10 per ton of ore for 6 per cent. cobalt and upwards, $20 per ton for 8 per cent., and $30 for 12 per cent. and upwards. Nickel and arsenic are not paid for by any buyer. The custom concentrators pay for 55 to 88 per cent. of the silver contents according to the grade of the ore; or will treat ore delivered at the mill at a certain charge per ton, say $4 or $5, and return the concentrates. The total quantity of ore treated by the custom plants was 30,487 tons, yielding 1,195 tons of concentrates.

The three smelting works mentioned as being in Ontario, namely, Copper Cliff, Deloro and Coniagas, are well-equipped refineries, successfully treating the ores of the Cobalt camp for silver. They receive most of the high grade ores produced by the mines, as well as a considerable proportion of the concentrates, the shipments of low grade ores continuing for the most part to go to smelters in the United States, where their silicious contents render them desirable for mixing with more basic material. The quantity of ore sent elsewhere was insignificant, some 137 tons being exported to Germany and England. In all, the Ontario refineries treated last year 8,444 tons of ore and concentrates, and recovered therefrom 12,239,538 fine ounces of silver in addition to a considerable quantity left in the speiss or residues reserved or exported for further treatment.

A theoretically complete treatment of the silver cobalt ores would result in the extraction not only of the silver, but also of the arsenic, cobalt and nickel contents of the ore. Of the first-named, 885 tons in the form of white arsenic were recovered in 1909, but a certain proportion passes into the speiss along with the cobalt and nickel. Cobalt oxide has not as yet been produced on a commercial scale, but small quantities have been obtained in an experimental way. Two of the refining plants, Deloro and Coniagas, are being equipped for the manufacture of cobalt oxide, and will doubtless be in a position to market their product in a short time. It does not yet appear that any profit is to be made in endeavouring to separate the comparatively small proportion of nickel which these ores contain.

There were employed in these reduction works 213 workmen, whose wages for the year amounted to $169,074.

Production and Prices

The total production of silver from the Cobalt mines beginning with 1904, when the first shipments were made, is shown in the following table:—

Table VI.—Silver Production, Cobalt Mines, 1904 to 1909

Year.	Producing Mines.	Shipments.		Silver Contents.		Average Silver Contents per Ton.		Value of Shipments.		Total Value
		Ore.	Concentrates.	Ore.	Concentrates.	Ore.	Concentrates.	Ore.	Concentrates.	
	No.	Tons.	Tons.	oz.	oz.	oz.	oz.	$	$	$
1904	4	158	....	206,875	....	1,309	....	111,887	....	111,887
1905	16	2,144	....	2,451,356	....	1,143	....	1,360,503	....	1,360,503
1906	17	5,335	....	5,401,766	....	1,013	....	3,667,551	....	3,667,551
1907	28	14,788	....	10,023,311	....	677	....	6,155,391	....	6,155,391
1908	30	24,487	1,137	18,022,480	1,415,395	736	1,244	8,468,293	665,085	9,133,378
1909	31	27,729	2,948	22,436,355	3,461,470	809	1,174	10,809,872	1,651,704	12,461,576
Total........		74,641	4,085	58,542,143	4,876,865	784	1,194	30,573,497	2,316,789	32,890,286

The price of silver remained comparatively steady throughout the year, the lowest figure, 50¼ cents per ounce, being reached on 4th March, and again on 26th and 30th October, and the highest, 53⅞ cents, on 5th May. That the fluctuations were confined to so small a range and the market was so well sustained, is attributed to a steady and continuous demand from buyers in China to redress the balance of trade, there being a substantial increase in the exports of that country, concurrent with stationary or diminishing imports. India has also, as usual, been an important factor in the price of silver, her purchases, though smaller than in 1908, yet being large, amounting to about $33,750,000. To China the shipments of silver from London were about $10,000,000, as against about $4,600,000 in 1908, and from San Francisco about $7,500,000. Prospects for good crops in India and improved trade conditions in China lead to the belief that the demand from these countries will be maintained during 1910, while the requirements of Europe and America for coinage purposes and use in the arts seem likely, on account of the general tendency towards revival in trade, to call for a greater quantity of silver.

Workmen and Wages

In the producing silver mines of the Cobalt camp, including South Lorraln, 2,998 men were employed last year, receiving wages to the amount of $2,446,354. As already stated, the silver refineries employed 213 men, and paid out wages to the extent of $169,074. Tbe custom concentrators required the services of 74 men, to whom they paid as wages $67,592. From non-producing mines in the Cobalt, Elk Lake and Gowganda districts returns have been received showing an aggregate employment of 477 men and of wages paid $271,222. There are numerous properties employing less labor singly and in a more spasmodic way, and also as yet in the non-producing stage, from

which no returns have been received. In the aggregate these properties employ a considerable number of men, and pay out a good deal of money for wages. In order to show the importance of the silver fields in the employment of labor, these several branches of the industry may be enumerated as follows:—

	Employees.	Wages.
Producing Silver Mines	2,998	$2,446,354
Silver Refineries	213	169,074
Custom Concentration Works	74	67,592
Non-producing Properties Reporting	477	271,222
" " Not Reporting (estimated)	1,000	500,000
Total	4,762	$3,454,242

Table VII., which follows, gives the total production of silver, cobalt, nickel and arsenic from the Cobalt mines from the beginning down to the end of 1909.

Table VII.—Total Production, Cobalt Mines, 1904 to 1909

Year.	Shipments, ore and concentrates.	Nickel.		Cobalt.		Arsenic.		Silver.		Total Value.
	Tons.	Tons.	Value.	Tons.	Value.	Tons.	Value.	Ounces.	Value.	
			$		$		$		$	$
1904	158	14	3,467	16	19,960	72	903	206,875	111,887	136,217
1905	2,144	75	10,000	118	100,000	549	2,693	2,451,356	1,360,503	1,473,196
1906	5,335	160	....	321	80,704	1,440	15,858	5,401,766	3,667,551	3,764,113
1907	14,788	370	1,174	739	104,426	2,958	40,104	10,023,311	6,155,391	6,301,095
1908	25,624	612	....	1,224	111,118	3,672	40,373	19,437,875	9,133,378	9,284,869
1909	30,677	766	....	1,533	94,965	4,294	61,039	25,897,825	12,461,576	12,617,580
Total	78,726	1,997	14,641	3,951	511,173	12,895	160,070	63,401,006	32,881,865	33,577,070

The following table of dividend-paying Cobalt companies (page 18) shows that up to the close of 1909 there was returned in dividends to the shareholders the sum of $14,526,068.32, exclusive of profits of mines privately owned, or owned by close corporations. Owing to the fact that in a number of cases the original capitalization was subsequently increased, the proportion of actual investment in these mines which has now been repaid cannot be computed, but taken in conjunction with Table VII., the figures demonstrate that more than one-half the gross proceeds of sales of ore have been paid out as dividends.

Details of Four Leading Mines

It may be interesting to give a synopsis of the last statements published for the information of shareholders respecting the operation of three or four of the leading mines of Cobalt, selecting for this purpose the Nipissing, Crown Reserve, Kerr Lake and Coniagas mines.

Nipissing

The fifth annual report of the Nipissing Mines Company, which is the holding company, being for the calendar year 1909, shows receipts of $1,535,000 by way of dividends on 2,500 shares of Nipissing Mining Company, the operating concern, which, with surplus on hand 1st January and interest, makes up an income of $1,543,989.40. Of this $1,500,000 was paid out as dividends, and $22,018.12 for expenses, leaving on hand the sum of $21,971.28. The statement of the Nipissing Mining Company for the same period, which follows immediately in the printed report, shows that during the year there were 6,230 tons of ore shipped (dry weight) and 183 tons of concentrates. Of this 1,048 tons were high grade ore of an average tenor of 3,094 ounces of silver per ton, 5,174 tons of low grade silicious ore averaging 212 ounces per ton, and 7.62 tons of nuggets averaging 19,771 ounces. The concentrates averaged 855 ounces per ton. The gross silver contents of the shipments were 4,646,877 ounces, having a value of $2,395,430, the average price per ounce received being 51.547 cents. The working account showed the total

Table VIII.—Statement of Dividends Paid by Silver Cobalt Mining Companies

Name of Company.	Date of Incorporation.	Authorized Capital.	Capital Stock issued.	Par value per share.	Amount of Dividends or Bonuses declared to end of 1908.	Amount of Dividends or Bonuses declared during 1909.	Total of Dividends or Bonuses declared to Dec. 31, 1909.	Date of last Dividend or Bonus.	Rate of last Dividend and Bonus.
		$	$	$	$ c.	$ c.	$ c.		per cent.
Buffalo Mines, Limited	April 27, 1906	1,000,000	1,000,000	1.00	317,000.00	320,000.00	637,000.00	Nov. 15, 1909	3
City of Cobalt Mining Company, Limited	Oct. 5, 1906 Jan. 7, 1909	500,000 1,500,000	1,500,000	1.00	44,483.70	94,828.72	139,312.42	April 15, 1909	3
Cobalt Central Mines Company	Dec. 13, 1906	5,000,000	5,000,000	1.00	95,230.00	97,615.00	192,845.00	Aug. 25, 1909	1
Cobalt Silver Queen, Limited	April 1, 1906	1,500,000	1,500,000	1.00	315,000.00	....	315,000.00	Dec. 1, 1908	5
Coniagas Mines, Limited	Nov. 26, 1906	4,000,000	4,000,000	5.00	800,000.00	360,000.00	1,160,000.00	Nov. 1, 1909	3
Crown Reserve Mining Company, Limited	Jan. 16, 1907	2,000,000	1,999,957	1.00	353,762.80	1,238,169.80	1,591,932.60	Dec. 31, 1909	15
Foster Cobalt Mining Company, Limited	Feb. 11, 1906	1,000,000	915,588	1.00	45,000.00	....	45,000.00	Jan. 1, 1907	5
Kerr Lake Mining Company, Limited	Aug. 15, 1905	40,000	40,000	100.00	840,000.00	750,000.00	1,590,000.00	Dec. 1, 1909	600
La Rose Mines, Limited	Feb. 21, 1907	6,000,000	6,000,000	1.00	120,000.00	995,000.00	1,115,000.00	Dec. 20, 1909	2½
McKinley-Darragh-Savage Mines of Cobalt, Limited	April 17, 1906	2,500,000	2,247,692	1.00	246,458.32	337,100.30	583,558.62	July 15, 1909	5
Nipissing Mining Company, Limited	Dec. 16, 1904	250,000	250,000	100.00	2,820,000.00	1,535,000.00	4,355,000.00	Dec. 20, 1909	7½
Right of Way Mining Company, Limited	July 13, 1906 Sept. 11, 1909	500,000 2,000,000	199,518 1,685,500	1.00 1.00	139,822.27	181,821.66 33,710.00	321,643.93 33,710.00	Oct. 1, 1909 Dec. 31, 1909	6 2
Temiscaming and Hudson Bay Mining Company, Ltd.	July 29, 1903	25,000	7,761	1.00	1,008,930.00	162,981.00	1,171,911.00	Nov. 22, 1909	300
Temiskaming Mining Company, Limited	Nov. 16, 1906	2,500,000	2,499,171	1.00	359,156.25	150,000.00	509,156.25	March 31, 1909	6
Trethewey Silver Cobalt Mine, Limited	May 30, 1906	1,000,000	1,000,000	1.00	217,453.50	244,545.00	461,998.50	Dec. 15, 1909	15
Total		33,315,000	31,745,212	.....	8,022,296.81	6,503,771.48	14,526,068.32	....	....

cost of operating the mine to be $383,152.11, of which the principal items were Development and Exploration, $144,714.03; Stoping, $81,684.86; Ore Sorting and Loading, $33,943.01; Insurance and Taxes, $27,205.34; Trenching, $26,668.91; General and Legal Expenses, $21,197.17. Concentration of ore cost $35,433.96; Marketing Ore, $263,223.83; Corporation, New York Office and Travelling Expenses, $12,483.13; and there was allowed for depreciation, $49,798.84. Shafts and Tunnels charged to Operation were put down at $71,039.18. Miscellaneous income amounting to $40,320.16 being deducted, the total cost of production was $774,810.89, or at the rate of $121.22 per ton of ore produced, or $0.1639 per ounce of silver. The apparently large cost of "marketing ore," $263,223.83, is explained by the details: Smelter deductions on silver, $119,821.77; treatment charges, $47,966.96; freight, $71,688.30; Assayers, Metallurgists, Smelter Representatives and Ore Insurance, $20,633.77; and Commission, $3,113.43. Adding receipts for cobalt, $19,832.91, and nickel, $14.04, the gross value of the ore produced was $2,462,039.67; deducting the total cost of production left a profit of $1,687,228.78. The report shows that the total shipments from the mine, beginning with 1904, were 14,862 tons, containing 12,747,648 ounces of silver, and that the value of the silver, cobalt, nickel and arsenic paid for was $7,422,707.09, the net returns from smelters being $6,694,460.83. Reserves of ore were placed at 6,539,200 ounces of silver, valued at $3,269,600. The net surplus of the Nipissing Mining Company, after allowing for accrued expenses on ore, accounts payable and January dividend, was $913,195.46, of which $813,347.89 was cash in bank. The capital stock of the Nipissing Mines Company is $6,000,000, and of the Nipissing Mining Company $250,000. The dividends for the year, if calculated on the former, were equal to 25 per cent., if on the latter to 600 per cent.

Crown Reserve

From sales of ore the Crown Reserve Mining Company, in 1909, realized $2,080,156.08. The expenses were: Mining, including Development and Depreciation, $265,813.09; Freight and Treatment charges and deduction made by smelters, $184,671.16; Bonus to Employees, $12,611.95; Royalty to Ontario Government (10 per cent., less proportion of expenses), $180,661.39; total, $643,757.59, leaving a profit for the year of $1,436,398.49. Out of this were paid dividends amounting to $1,238,169.80, and $549,275.42 was carried forward to next year. The quantity of silver produced was 4,034,325 ounces. Expenditure on buildings, machinery and equipment from the time the mine was opened up to 31st December, 1909, was $137,054.05. The capital stock of the company is $2,000,000, and $1,591,932.60 have been returned to shareholders in dividends. Excluding the royalty payments, the above figures show the cost of producing silver to be 11.47 cents per ounce.

Kerr Lake

The capital stock of the Kerr Lake Mining Company is $3,000,000, being composed of 600,000 shares of a par value of $5 each. The mining property consists of 57 acres at Kerr Lake, in Coleman township. The company's published report for the year ending 31st August, 1909, shows that the production for the year amounted to 2,668,648 ounces of silver from 1,072 tons of ore, the average contents of which were 2,489 ounces per ton, and 300 tons of screenings. The gross value of the silver at 50 cents per ounce was $1,334,324; actual proceeds of sales, with adjustments for ore mined, on hand and in transit, 31st August, 1908, and 31st August, 1909, were $1,382,290.15. Adding interest, $4,254.22, the total receipts were $1,386,544.37. Cost of Production and Development was $200,050.35; of Shipment, Treatment and other charges, $47,288.60; and of Administration and General Expenses, New York, $10,157.88, leaving a net profit of $1,129,047.54. The chief items in the working expenses were: Development, $82,078; Mining, $71,861.39; Taxes, $17,143.49; Ore Sorting, $12,501.36; Repairs, $3,581.99; Stable Expenses, $3,264.75; General Expenses, $3,006.15; Office Expenses, $2,957.60. Ore treatment cost $17,263.27; Concentration, $13,290.61; Freights, $8,881.10; Insurance, $2,388.20; and Shipment expense, $2,630.12. The cost of producing and marketing the silver was 12.38 cents per ounce. The Kerr Lake Mining Company, Limited, capital $40,000, is the operating

company, and shows a balance on hand at the end of the year of $962,217.48. It is noted in the report that the deepest workings of the mine, in No. 3 shaft, were now down 350 feet, where there was pay ore. One drift on No. 7 vein at the 150-foot level, 60 feet long and 9 feet wide, produced 94,000 ounces of silver. There were two miles of underground workings.

Coniagas

The financial report of the Coniagas Mines, Limited, for the year ending 31st October, 1909, shows assets of $4,561,626.18, the principal items of which are: Mines and Minerals, $3,985,700; Coniagas Reduction Company, $151,971.85; ditto stock, $100,000; and Imperial Bank, $128,477.34. Against this the liabilities are: Capital Stock, $4,000,000; dividend payable, $120,000; and one or two minor items, leaving surplus to balance, $440,013.92. The "Working Account" shows on the debit side the expenses of operating for the year, such as: Mining, $78,274.57; Milling and Sorting, $39,143.63; Fuel, Oil and Waste, $29,842.56; Camp Expense, $15,261.65; Head Office and Administration, $14,368.50; Taxes and Royalties, $13,330.69; Mines Office and Supervision, $10,200.13, etc., in all $214,169.06. On the credit side the chief items are: Ore Revenue, $674,889.27; Camp Revenue, $13,478.23; total, $691,579.90; surplus closed into Loss and Gain account, $477,410.84. The Loss and Gain account shows that three dividends of $120,000 each were paid the shareholders; Bonus to Employees, $2,474.98; Directors' Fund, $1,500; leaving a balance of $440,013.92. During the year the production of ore and concentrates amounted to 776 tons, containing 1,407,228 ounces of silver; for the whole life of the mine so far the mine had yielded 4,347½ tons of ore, and concentrates carrying 4,863,323 ounces. In all, 60,229 tons of ore and rock had been removed during that time, of which 33,229 tons of rock were put through the concentrating mill. The estimate of ore in sight was: High grade 3,427 tons, containing 9,125,500 ounces of silver; and milling rock 103,000 tons, containing 3,432,200 ounces; total, 12,557,700 ounces. The cost of producing and selling the silver product, deduced from the foregoing figures, was 15.21 cents per ounce.

The silver production of these four mines last year, and the cost of producing and marketing the same per ounce, were as follows:—

	Silver produced, oz.	Cost per oz., $
Nipissing	4,646,877	0.1639
Crown Reserve	4,034,325	0.1147
Kerr Lake	2,668,648	0.1238
Coniagas	1,407,228	0.1521

The Lesser Cobalts

Considerable progress has been made in the development of the lesser Cobalt silver fields, namely, South Lorrain, Gowganda, and the Montreal River generally. Much money has been spent and most energetic efforts have been made to prove the value of these several camps—efforts which have been deterred by no difficulty, however great, interposed by climate, distance or imperfect means of transportation.

There was a small output of ore from the Keeley mine in South Lorrain in 1908, and last year the Wettlaufer, in the same district, joined the producing ranks. The shaft on this mine had been sunk in March, 1910, to a depth of 152 feet, and two levels run, one at 60 and the other at 134 feet. Considerable drifting and cross-cutting had been done, and a good surface equipment provided of boilers, compressor plant, hoist, etc., as well as the necessary buildings. Other promising properties are the Newman, or R.L. 470, on which a good vein of calcite, smaltite and niccolite with native silver was found last autumn; the Haileybury Frontier, south half H.R. 16; Little Keeley, H.S. 40; Beaver Lake, H.R. 21; and Maidens, H.R. 690. The South Lorrain camp is waiting for electric power from the Matabitchouan, where the Mines Power, Limited, is developing a large water power. When this begins to be delivered, as it probably will be in the

spring of 1910, developments will be more easily and economically made. The production of silver in South Lorrain last year was 194,955 ounces, valued at $99,859; and from Maple Mountain 18,002 ounces, worth $8,421.

A good deal of ore was accumulated at several of the Gowganda mines during development operations carried on in 1909, some of it of first-rate quality. The summer roads not being fit for the transportation of such heavy material except at undue cost, the ore remained in the ore houses until winter—the great highway-maker of Northern Ontario—should enable it to be moved The first consignments from Gowganda were made by the Millerett Silver Mining Company, Limited, from the mine on Claim M.R. 1081, in the township of Haultain, Temagami Forest Reserve, but as the ore was not loaded on the cars of the T. & N. O. Railway at Charlton until the first day of January, 1910, the shipments are not included in the production of 1909. This carload, which was consigned to the Canadian Copper Company's smelter at Copper Cliff, had a dry weight of 64,952 pounds, and contained 104,714 ounces of silver, an average of 3,224 ounces per ton. This was followed early during the present year by shipments from the same mine, and also from the Reeves-Dobie, Boyd-Gordon, Lucky Godfrey and one or two other properties, the total shipments for the first three months of 1910 from Gowganda and Montreal River being 320 tons. Part of this was brought out by the T. & N. O. railway from Charlton station, and part of it by the Canadian Northern, being delivered at Sellwood station by way of the road from Gowganda lake to that point. Shipments by the former route amounted to 230 tons, and by the latter 89 tons.

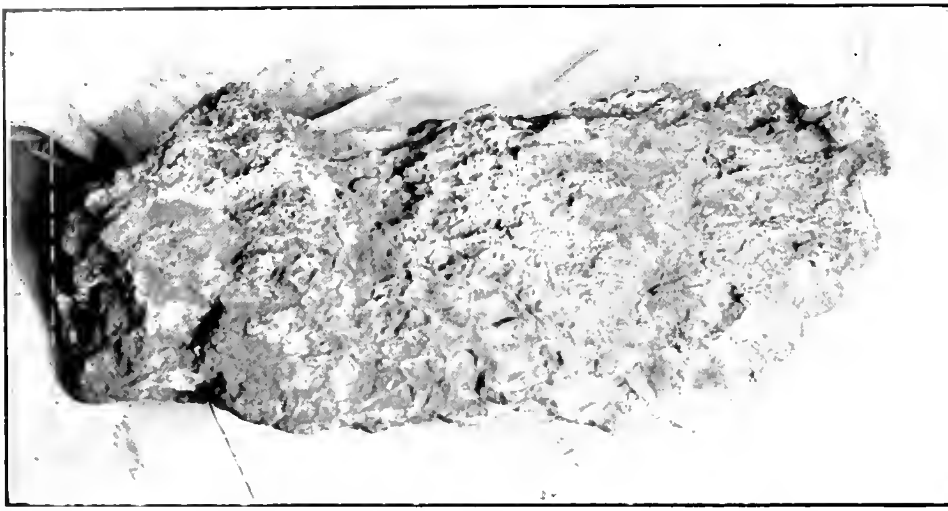
A Silver Specimen Worth Preserving

In prospecting on the Gem mining claim near Giroux lake (southwest part lot 3 in the fourth concession of Coleman township) a nugget or large piece of float was found which was almost completely covered by soil. This is the largest piece of rich float found in the Cobalt district up to the present time, and is probably the largest known block of silver ore now existing anywhere. The maximum dimensions are 5 feet 5 inches by 2 feet 5 inches by 1 foot 6 inches, as shown on accompanying photographs. The weight was 1,640 pounds. As can be seen, one part is exceedingly rich, consisting of native silver in plates, in places presenting the appearance of filagree work and in others forming into masses. This was undoubtedly the vein matter, the other part adhering country rock. The native silver is probably mixed with dyscrasite, as an assay of the selected metallic portion showed that it contained 90.32 per cent. silver, the impurity being antimony. The highest known percentage of silver in dyscrasite is 83.85. Mr. C. W. Knight's description, given below, of sections made from this country rock shows that it is Huronian greywacké, whereas the country rock on the claim is diabase. The plan given shows the nearest Huronian rock is about 3,000 feet distant. In all probability this float came from one of the large veins in the rich Kerr lake section. Mr. C W. Knight describes it thus:—

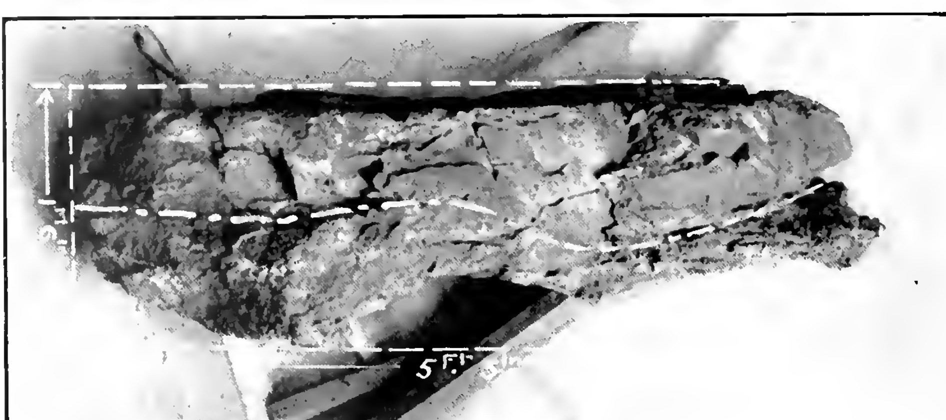
The rock is a fine-grained greywacké of Lower Huronian age, similar to the Cobalt greywackés. It consists partly of bits of the different rock types, basalt, feldspar—porphyry and chert, and partly of fragments of the simple minerals, quartz and feldspar. This material is set in a ground-mass made up of the same débris in a finer state of division, together with chlorite, epidote, zoisite and calcite.

This nugget appeared to be of so much interest, both as illustrating the transporting power of some agency, undoubtedly glaciers, and also the lavish way in which nature can act at times, that it deserved to be kept for all time and placed on view in a public museum, and not simply utilized as a source of silver. On representations being made to the Minister of Lands, Forests and Mines, he decided to save the nugget from the smelting furnace, and to purchase it from the owners for the value of the silver it contained. This was accordingly done, and the nugget is now on exhibition in the Parliament Buildings, Toronto.

The silver was masked to a great extent by discoloration and a coating of cobalt bloom; this was cleared off in places by the use of a sand blast, and the result was to show the block to be much richer in silver than it previously appeared to be. No smaltite was disclosed by the action of the sand blast. As only two constituents existed in large quantities in the mass (the cobalt bloom being relatively insignificant in amount), and as the country rock and calcite of the vein matter were nearly identical

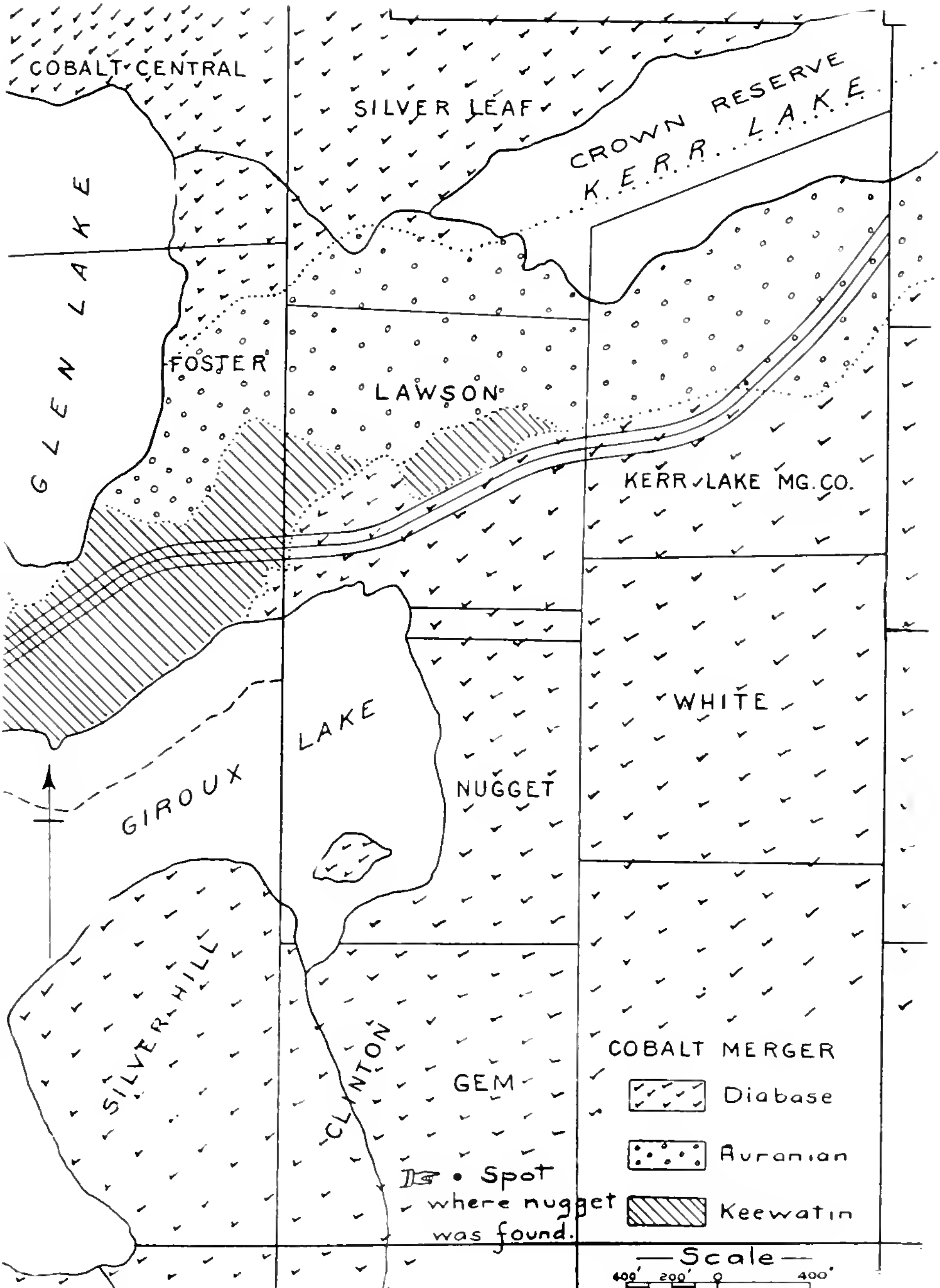


Photograph of Cobalt Gem silver nugget. Practically the whole surface shown is silver.



Side view of nugget, showing rock matter overlaid by silver.

in specific gravity, it was possible to determine the amount of silver without mutilating the nugget, by taking the specific gravity of the block as a whole and from this calculating the silver contents. Facilities for this were kindly furnished in the mining building of the University of Toronto. The determination showed that there were 9,715 ounces of fine silver in the mass, and settlement was made at the current market price of silver.



Plan showing spot on Gem property, Cobalt, where nugget was found.

As stated before, probably no nugget is known at the present time to compare witl this in size. In Schneeberg, according to Beck, Erzlagerstätten, p. 368, and Stelzner Erzlagerstätten, Part II., p. 727, a block of ore was found weighing 20 tons and measur ing 12 feet by 6 feet, length and breadth. Fragments of this are in the Dresdei museum to-day; they consist of silver, argentite, ruby silver and horn silver. As th gangue matter in the Schneeberg veins was principally barite with fluorite and calcite and therefore with specific gravities of 4.5 to 2.7, and the metallic minerals had specifi gravities of 10.6 down to 5.5, it is probable that the specific gravity of the whole mas was somewhere about 5 or less; the other dimensions would then be 1 foot 9 inches— the probable width of the vein. This calculation agrees with the historical records which show that in 1474 the Grand Duke of Saxony was entertained at a banque underground, at which the block of ore was used for a table.

Typhoid Fever and Sanitation

An outbreak of typhoid fever visited the mines of Cobalt last summer, along witl the towns and settlements of northern Ontario generally. The conditions pertaining to water supply and sanitation in mining camps and towns which are rushed up unde the influence of a "boom" are such as to afford every facility for epidemics of this kind if not practically to invite them, but there is no reason to believe that the mines them selves were worse in this respect than the towns and villages. Indeed, most of the mine showed a cleaner bill of health than the other centres of population, and not infrequentl typhoid cases appearing in the mines could be traced to the settlements. Greatly t the credit of the mining companies, they organized and maintained largely at their owi expense a Red Cross hospital at Cobalt for miners suffering either from typhoid or an other disease, or from accidental injury. The management and operation of the hospita was very successful, and did much to alleviate the severity of the epidemic. The hospita has since been incorporated, with the mining companies as the shareholders, and futur visitations can be coped with from the beginning. So far as the town of Cobalt i concerned, a supply of good water is being obtained from lake Sasaginaga, which wil go far to minimize the danger of typhoid epidemics.

Cobalt

The cobalt oxide trade is at present demoralized, and is likely to remain in this con dition until a greatly increased use of the article enables the demaud to overtake th supply. The enforced production of cobalt ore from the mines of Cobalt has resulte in a much greater quantity of ore than can be converted into oxide and marketed a such. In fact, one year's operation of the Cobalt mines will produce ore enough to mee the present consumption of oxide for several years. The inevitable consequence has bee a very decided fall in the price of cobalt oxide. Before the mines of Cobalt were opened the ruling price was about $2.50 per pound, while now it is 80 or 85 cents per pound Cobalt ore cannot at present be sold, and none is being raised from any of the silver-fre veins of the Cobalt camp, the entire production being of ore associated with silver. Th refining works at Deloro and Thorold will, it is expected, soon enter the market wit cobalt products, which will not tend to an increase of price. The only hope of absorbin the cobalt contents of the ores which will continue to be produced in Ontario is in a enlarged demand, brought about either by the low levels to which the prices have fallen or by new uses for the product. It is not unreasonable to expect that the former wil lead to the latter.

Owing to the fact that no value is attached to a large proportion of the cobalt con stituents, accurate records of the actual production are wanting, but for statistical pur poses it is here assumed that the ores and concentrates shipped from the Cobalt mine last year contained on the average 5 per cent. of cobalt, which would give a productio of 1,533 tons. Sales of cobalt yielded mine owners $94,965. The cobalt output, thoug for the present largely unmarketable, is not being thrown away, and the accumulation of past and future years will no doubt eventually find their way to utilization.

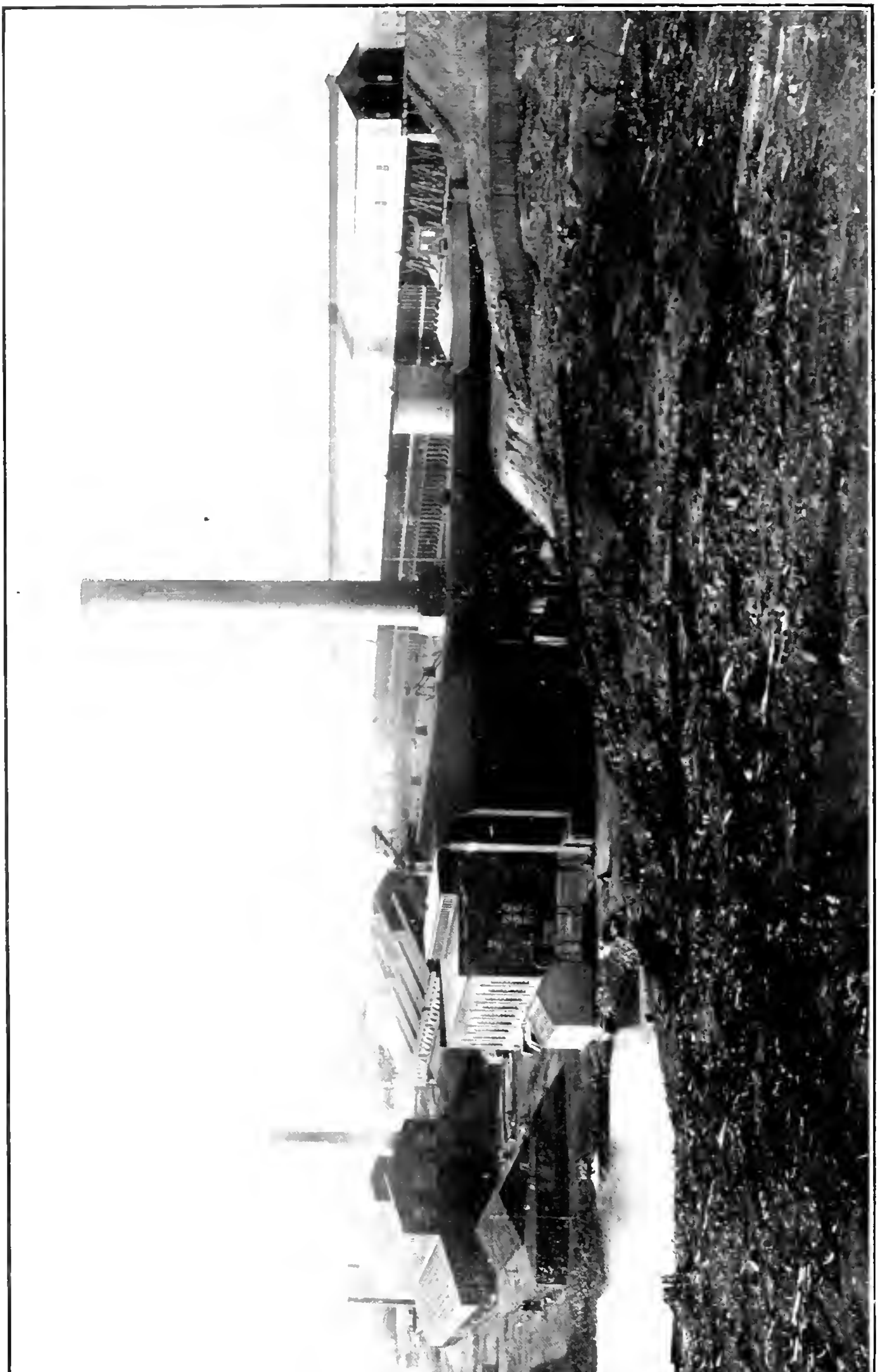
Nickel

The nickel-copper mines of the Sudbury region yielded last year 451,892 tons of ore. There were 462,336 tons charged into the smelters and converted into 25,845 tons of bessemerized matte, the estimated contents of which were 13,141 tons of metallic nickel and 7,873 tons of metallic copper. In 1908 the mattes produced amounted to 21,197 tons, containing 9,563 tons of nickel and 7,501 tons of copper, the output of nickel for 1909 being thus 37 per cent. greater than in 1908. The estimated nickel contents of the ore raised from the silver-cobalt mines of Cobalt were 766 tons, computed at 2½ per cent., making a total nickel yield of 13,907 tons. No value is ascribed in the tables of production to the nickel from Cobalt, since little or none of it so far has been utilized. This, however, may not continue to be the case, and in any event the nickel of the Cobalt ores, being the product of Ontario mines, is entitled to be reckoned as such, regardless of its present value. The whole nickel output is returned as being worth $2,790,798, and the copper contents of the Sudbury mattes at $1,122,219.

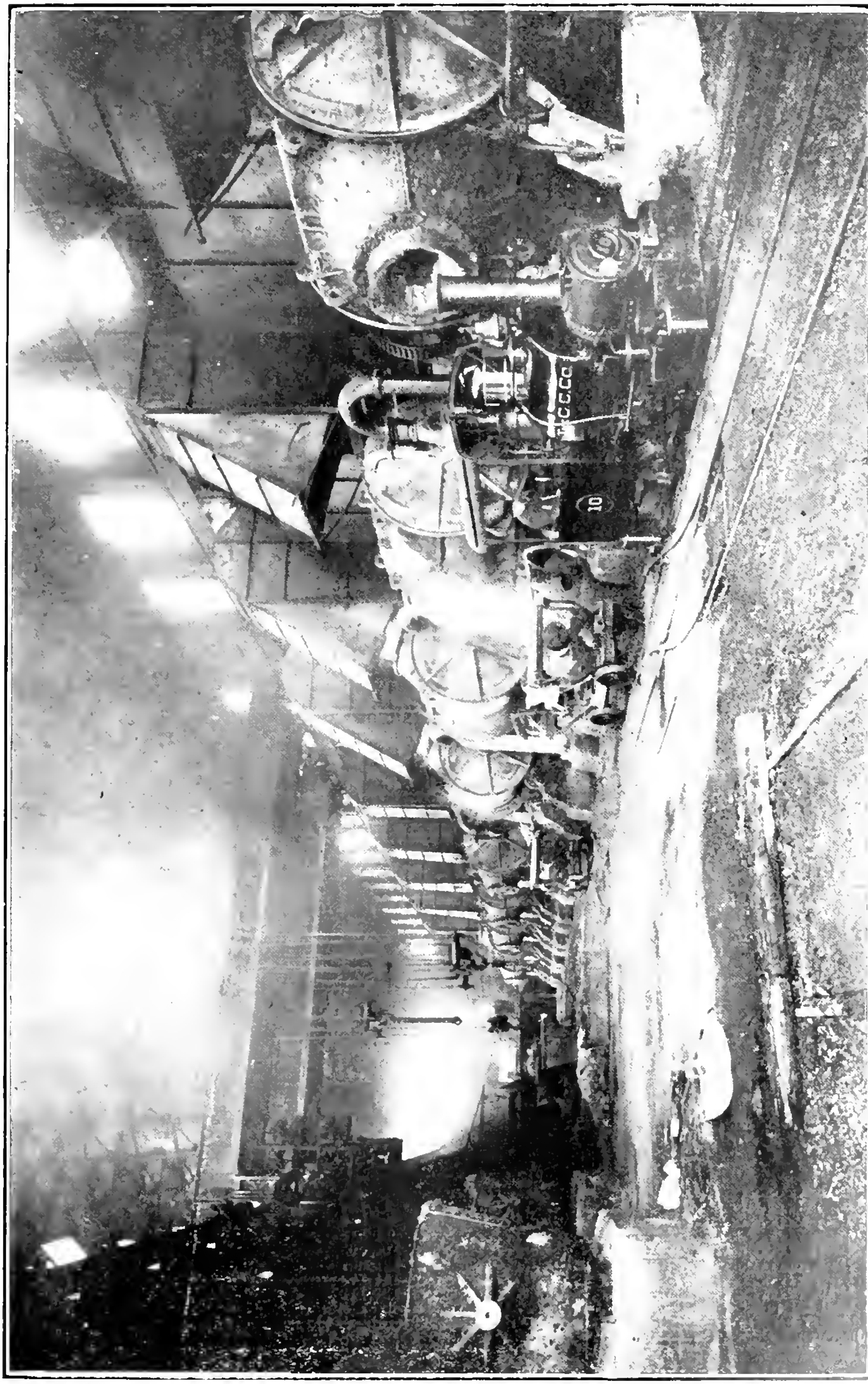
The Canadian Copper Company continues to lead in the production of nickel, their works at Copper Cliff being fully occupied during the past year. The ore treated by them was extracted from the following mines:—Creighton, 245,573 tons; Crean Hill, 100,312 tons; Vermilion, 702 tons; and Evans, 2,713 tons.

Monel Metal

In the last Report of the Bureau mention was made of "Monel metal," a natural alloy of nickel and copper, which is being produced from the Canadian Copper Company's mattes without previous separation of the metals. It contains about 68 per cent. of nickel, 1½ per cent. of iron, the remainder being copper, and greatly resembles the former metal in appearance. It is claimed to be non-corrosive, and owing to its being made direct from the matte, it can be produced and sold at a price which enables it to compete with bronze, German silver, etc. Monel metal sheets are being used, among other purposes, for the roofing of buildings, for which it is said to be superior to copper. The roof of the large terminal of the Pennsylvania Railroad in New York was made of this alloy, 250,000 square feet of roofing, in addition to cornices, gutters, leaders, etc., requiring over 150 tons of the material. For the roof of the Chicago and North Western Railway station in Chicago, equal in extent to four city blocks, 75 tons of Monel metal will be used, and 109 tons for the buildings of the Orford Copper Company at Bayonne, New Jersey, having a roof area of 140,480 square feet. For mine screens it is replacing manganese bronze in the anthracite regions of Pennsylvania, on account of its resistance to the corrosive action of the sulphuric acid present in the wet coal passing over the screens. The same property gives it value where metals are affected by salt water or acid solutions, as in propeller blades, yacht and steam launch construction, and other shipbuilding uses, and for vessels employed in chemical works for handling corrosive liquids. Owing to its high melting point, "Monel metal" is somewhat difficult to cast, special equipment being required for the purpose. It comes in castings, hot rolled sheets, cold rolled sheets, bars, rods and wire. A lathe can be run at the same speed with "Monel metal" as with ordinary steel, and there is no difficulty in forging, soldering, brazing or electrically welding it. Its melting point is 1,360 deg. C. (2,480 deg. F.); specific gravity (cast), 8.87; weight per cubic inch, 0.319 lb.; co-efficient of expansion (20 deg. C.—100 deg. C.), .00001375 per 1 deg. C.; electrical conductivity 4 per cent., as compared with copper 100 per cent.; heat conductivity, one-fifth that of copper; modulus of elasticity, 23,000,000; shrinkage, one-quarter inch per foot. There would appear to be a wide field of usefulness open to this new alloy, and for pumps and other uses in mines where the water is bad and corrodes ordinary steel it would seem to have special advantages.



General View of Smelter, Canadian Copper Company.



Converter Departments, Canadian Copper Company.

The Mond Nickel Company,[4] whose works are at Victoria Mines, brought to the surface 102,592 tons of ore, of which 38,311 tons came from Victoria Mine No. 1, Denison township, and 64,281 tons from the Garson Mine, Garson township.

The Dominion Nickel Copper Company have been engaged in building a line of railway from the Canadian Northern through the township of Norman to the Whistle Mine and other properties near Blue lake, but so far have not begun to raise ore.

No further developments have taken place with regard to the nickeliferous pyrrhotite bodies found in Dundonald and Clergue townships, west of the T. & N. O. Railway, mentioned in the Eighteenth Report.

The following statistics show the progress of the nickel-copper mining and smelting business during the five years ending with 1909:

Table IX.—Nickel-Copper Mining, 1905 to 1909

Schedule.		1905.	1906.	1907.	1908.	1909.
Ore raised	tons	284,090	343,814	351,916	409,551	451,892
Ore smelted	"	257,745	340,059	359,076	360,180	462,336
Bessemer matte produced	"	17,388	20,364	22,041	21,197	25,845
Nickel contents	"	9,503	10,776	10,602	9,563	13,141
Copper contents	"	4,525	5,260	7,003	7,501	7,873
Value of Nickel	$	3,354,931	3,839,419	2,270,142	1,866,059	2,790,798
Value of Copper	"	688,993	806,413	1,020,913	1,062,680	1,122,219
Wages paid	"	833,822	1,117,420	1,278,694	1,286,265	1,234,904
Men employed	No.	1,176	1,117	1,660	1,680	1,796

The figures at which the nickel and copper contents are valued in the above table are those placed upon them by the mining companies themselves. They correspond to 10.6 cents per pound for nickel, and 7.1 cents per pound for copper. For the former metal the value seems low, compared with 40 cents per pound, the minimum quotation for refined nickel in New York during the year. It is quite probable, however, that for large contracts sales are made at a considerably smaller figure.

In "heap-roasting" the green ore some 17,642 cords of wood were consumed, costing $53,988, or $3 per cord, and in smelting the roasted ore and converting it into a bessemer matte containing about 80 per cent. of metallic contents 76,138 tons of coke were required, valued at $552,642, or $7.25 per ton.

Copper

The output of copper is largely dependent upon that of nickel, since the source of nearly all the copper produced in this Province is the cupriferous pyrrhotite of the nickel mines of Sudbury. The production from these mines amounted last year to 7,873 tons, a larger quantity than in 1908, but not proportionately so to the tonnage of ore smelted, which was much greater than in 1908. In the latter year there were put through the smelters 360,180 tons of ore, the resulting copper in the matte being estimated at 7,501 tons, while in 1909 462,336 tons of ore yielded 7,873 tons of copper.

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[4] The Mond Nickel Company has had a successful career. The company dates back to 1901, and, as shown by the *London Statist* of July 2, 1910, the net profits and dividend payments during the last eight years have been as follows:—

Year.	Net profit. £	Dividend on Ordinary shares. per cent.	Deferred Dividend per cent.
1903	2,095	..	..
1904	17,197	..	..
1905	30,916	6	..
1906	56,515	10	18
1907	100,665	12½	33
1908	125,007	15	48
1909	117,179	15	48
1910	120,112	15	48

—a total net profit of £569,586, or say $2,768,197. The capital of the company is £750,000, divided into £400,000 7 per cent. cumulative preference shares, £300,000 ordinary shares, and £50,000 deferred shares. £5 preference shares are quoted at 6¾, and £1 ordinary shares at 2¾.

The only non-nickeliferous copper mines in operation last year were Bruce Mines and Hermina, whose combined shipments are estimated to have contained 60 tons of copper. Bruce Mines, fifty years ago, was a busy place, where the Cornish miners earned good wages and turned out a great deal of copper ore, which, dressed by the methods then in vogue up to 18 or 20 per cent., was shipped to Swansea or, until the duty became prohibitive, to the United States. The fitful efforts to resume the working of the deposits which have been made from time to time have not resulted in much success, but the property has now passed into the possession of a company headed by Mr. R. W. Leonard, of St. Catharines, who is also president of The Coniagas Mines, Limited, the well-known silver mine at Cobalt. It is proposed to thoroughly explore the veins and to work them to the best advantage. The widespread occurrence of copper sulphide ores in that part of the Province adjacent to the north shore of Lake Huron affords ground for the belief that when local facilities are provided for the successful smelting of these silicious ores, this region will become an important producer of copper.

Iron Ore

Five iron mines last year produced 263,777 tons of ore. Of these, two yielded hematite, namely, the Helen mine, Michipicoten, owned by the Lake Superior Corporation, and the Dominion Bessemer Ore Company's property, near Loon lake, east of Port Arthur; and three magnetite—Moose Mountain, Atikokan and Bessemer (formerly Mineral Range), in Mayo township, Hastings county. The output of hematite was 197,193 tons, and of magnetite 66,584 tons, the value of the whole being returned as $645,622.

The ore shipped by the Dominion Bessemer Ore Company was the first taken from the flat-lying beds of hematite which have for some years been known to exist in the rocks of the Animikie formation in and near the township of McTavish, on the north shore of Lake Superior. These rocks and the accompanying ore bodies are described by Mr. W. N. Smith in the Fourteenth Report of the Bureau of Mines (1905), pp. 254-260, and also by Mr. L. P. Silver in the Fifteenth Report, pp. 156-172.

The Lake Savant iron range area is described in this report by Dr. E. S. Moore, who has explored, first as assistant to Dr. A. P. Coleman, late geologist and metallurgist on the Bureau's staff, and afterwards independently, a number of the localities in Northern and North-western Ontario in which the iron formation is developed.

Pig Iron and Steel

The seven blast furnaces in Ontario were all operated last year, most of them continuously. The Algoma Steel Company, Sault Ste. Marie, and the Hamilton Steel and Iron Company, Hamilton, have two furnaces each; the Canada Iron Corporation, Midland, the Standard Chemical Works, Deseronto (formerly Deseronto Iron Company), and the Atikokan Iron Company, Port Arthur, one each. The output of pig iron was 407,013 tons, valued at $6,301,528, as compared with 271,656 tons, valued at $4,390,839, in 1908. Of steel, which is made by the Sault Ste. Marie and Hamilton plants, the output was 296,031 tons, valued at $6,759,960. At Sault Ste. Marie the product was confined to standard T rails, the whole output of the blast furnaces and a large quantity of purchased pig being converted into this article. At Hamilton the product was basic open-hearth steel, 76,085 tons being in the shape of ingots and 700 tons steel castings. In the other departments of the Hamilton Company's extensive plant the products of the furnace were further developed into 3,359 tons billets, 289 tons miscellaneous forgings, 3,788 tons spikes, 626 tons axles, and 73,071 tons bar iron and steel.

Details of the blast furnace operations are found in the following figures:—

Ontario ore smelted	tons	220,307
Foreign " "	"	543,544
Scale and mill cinder	"	14,486
Limestone for flux	"	226,991
Coke for fuel	"	436,707
Value of do.	$	1,985,296

Charcoal for fuel	tons	973,413
Value of do.	$	102,208
Pig iron product	tons	407,013
Value of do.	$	6,301,528
Workmen employed	No.	1,125
Wages paid	$	689,818

The Ontario Iron and Steel Company, in its works at Welland, produced a quantity of open-hearth basic steel from scrap material, along with about 100 tons of imported iron ore. The Electro-Metals Company, of the same place, are carrying on a large business in the manufacture of ferro-silicon, the raw materials being iron ore imported from the United States, and silica in the form of rock or flint, brought from Frontenac county or Parry Sound district. The company makes use of about 7,000 electric horse power in its furnaces and works.

Table X. gives the figures for the iron and steel making plants of Ontario for five years ending with 1909:—

Table X.—Production Iron and Steel, 1905 to 1909

Schedule.		1905.	1906.	1907.	1908.	1909.
Ontario ore smelted	tons	61,960	101,569	120,156	170,215	220,307
Foreign ore smelted	"	383,459	396,463	388,727	342,747	543,544
Limestone for flux	"	121,052	153,702	171,037	179,741	226,991
Coke	"	262,415	304,676	326,937	322,817	436,707
Charcoal	bush.	3,387,869	811,926	1,849	....	973,413
Pig iron	tons	256,704	275,558	286,216	271,656	407,013
Value of pig iron	$	3,909,527	4,551,245	4,716,857	4,390,839	6,301,528
Steel	tons	138,387	167,026	237,855	172,108	296,031
Value of steel	$	3,721,884	4,202,278	4,168,127	4,397,082	6,759,960

Zinc

The production of zinc ore last year was 895 tons, all from the county of Frontenac. Some London (Ont.) parties have done a little development work on lots 29, 30 and 31, in the third concession E.B.R., Albemarle township, Bruce county, where showings of zinc ore have been found in the limestone.

Construction Materials

These are brick, lime, stone and cement.

Brick

As compared with 1908, the output of common brick rose from 222,361 thousand to 246,308 thousand last year, and the value from $1,575,875 to $1,916,147. There was a decided increase also in the value per thousand, the average being $7.78, as compared with $7.09 in 1908. The demand for brick was active during the year, especially in the larger cities, building operations in Toronto, for instance, which is essentially a city of brick, being decidedly brisk. A large quantity of brick is manufactured in and around Toronto, many of the brickyards being extensive and well equipped. Reference to the figures published by the Bureau as to the production of brick shows that the average value at the yard has risen from $5.73 per thousand in 1901 to $7.78 per thousand in 1909, an increase of over 35 per cent. The cost of brick constructions has been heavily affected during the same time, since the cost of labor has experienced an advance probably quite as great.

There has of late years been a marked improvement in the quality of brick made in first-class yards. Kilns of modern construction burn harder and more evenly, and there is a smaller proportion of soft brick. The present taste in brick houses, too, does not demand the same uniformity of color that was formerly insisted upon; in fact, a variety of shade, instead of being objected to, is rather desired. There is also a much greater range of products than was made years ago. From white and buff to cherry red and up

to a dark, even purplish, hue, bricks of all tints and shades are freely used, and pleasing effects are sometimes obtained by employing clinker or over-burned bricks, greenish or yellowish in color. The hard-burned bricks of the present day bid fair to give us durable towns and cities, not perhaps so handsome as those built of stone, but less subject to disastrous conflagrations than those made of wood, so much employed south of the line.

Of all varieties of brick there were made last year $2,480,418 worth, comprising common $1,916,147, pressed $490,571, and paving $73,700. In the brick and tile yards there were 3,166 men employed, earning $961,881 in wages. The brick-making season is for the most part confined to the months of late spring, summer and early fall. This, and not a low rate of wages, accounts for the comparatively small earnings of brick-makers, which last year averaged only $303.

Lime and Stone

The activity in building operations last year is reflected in the increased output of lime, of which 2,633,500 bushels were made, as compared with 2,442,331 bushels in 1908. The value also went up to $470,858, as against $448,596.

The building trade in Ontario is well served, not only by the abundance of clay suitable for the making of brick, but also by the widespread distribution of limestone which can be burned into lime. In composition the rock varies from nearly pure carbonate of lime to dolomite, in structure from crystalline to fossiliferous, and in geological age from Archean to the upper members of the Devonian series, but almost all kinds will make good lime. The idea that highly magnesian limestones are unfitted for lime has been shown to have no foundation.

The value of the building and crushed stone produced last year was $660,000, of which $228,000 worth was limestone used as flux in blast furnaces. The output of the stone quarries in Ontario varies from year to year, not only in accordance with the fluctuations in the building trade, but also in accordance with the demand for large public works. It is also adversely affected by the growing use of cement, which is being more and more applied to uses for which stone was formerly employed. The greater part of the product is limestone.

Portland Cement

The only kind of cement now being made in the Province is Portland cement, the manufacture of the natural rock variety having come to an end in 1907. Of Portland cement, however, the output has been annually increasing since 1891, when the industry began. Last year there were made 2,303,263 barrels, valued at $2,897,348, as against 2,022,877 barrels, worth $2,417,769 in 1908, the average price for last year being $1.257 per barrel at the factory, as compared with $1.195 in 1908, an increase of $0.061 per barrel.

The chief feature of interest in the industry last year was the formation of the Canada Cement Company, Limited, with headquarters at Montreal, a "merger" which united under one management the following plants in Ontario, as well as three factories in Quebec and one in Alberta, namely, Lehigh, Belleville, Marlbank, Port Colborne, Lakefield and Shallow Lake. The following companies were absorbed by the merger: Belleville Portland Cement Company, Belleville; Lehigh Portland Cement Company, Belleville; Canadian Portland Cement Company, Marlbank and Port Colborne; Lakefield Portland Cement Company, Lakefield; Owen Sound Portland Cement Company, Shallow Lake. There now remain outside of the "merger" the following cement companies in Ontario: Maple Leaf Portland Cement Company, Atwood; Grey and Bruce Portland Cement Company, Owen Sound; National Portland Cement Company, Durham; Superior Portland Cement Company, Orangeville; Imperial Portland Cement Company, Owen Sound; Crown Portland Cement Company, Wiarton (formerly Colonial Portland Cement Company); Ontario Portland Cement Company, Blue Lake; Hanover

Portland Cement Company, Hanover; Kirkfield Portland Cement Company, Kirkfield; Ben Allen Portland Cement Company, Owen Sound; and Sun Portland Cement Company, Owen Sound. Of these the Imperial, Crown and Ben Allen companies were idle throughout the year, and the Maple Leaf and Grey and Bruce operated for part of the year only. The output of the independent companies was small compared with that of the combine, which produced the bulk of the cement made last year. The industry gave employment to 1,354 men, whose wages amounted to $631,137.

Drain Tile and Sewer Pipe

The number of drain tile made last year was 27,418,000, having a value of $363,550. Tile draining is being more and more practised by the farmers of Ontario, who recognize the advantage of freeing their low-lying lands of surplus moisture, which retards the growth and maturing of their crops and invites early frosts. The production in 1908 was valued at $338,658.

Of four sewer pipe factories, three were in operation in 1909, namely, those of the Hamilton and Toronto, Dominion, and Ontario Sewer Pipe companies. The output had a value of $311,830, as against $344,260 in 1908.

From the potteries of Ontario there were turned out in 1909 $43,214 worth of goods.

Arsenic

The silver-cobalt ores of Cobalt are the source of all the arsenic at present being produced in Ontario, though they are by no means the only arsenical deposits. In Hastings county, as is well known, there are important bodies of arsenopyrite, some of it auriferous, which in times past have been operated vigorously. There are similar ores at Arsenic lake, Temagami Forest Reserve, and elsewhere in northern Ontario. If the demand for arsenic were such as to require a larger output, there would be little difficulty in materially increasing the production.

From the silver-cobalt refineries at Copper Cliff, Deloro, and Thorold there were shipped last year 1,085 tons of white arsenic, valued at $61,039, or 2.81 cents per pound. In 1908 the output was 702 tons and the value 2.87 cents per pound. Besides this, some 537 tons of arsenic were contained in the speiss product of the refining works, a large part of which was sent abroad for treatment. In all, the total production of arsenic is estimated to have been 4,303 tons, allowing the average arsenic contents of the ore and concentrates shipped from the Cobalt mines to have been 14 per cent. No returns are received by the ore producers for arsenic. The value, $61,039, shown in the table of production is wholly for the shipments of white arsenic made by the refining companies.

Iron Pyrites

There were shipped from the iron pyrites mines of the Province last year 28,946 tons of ore, valued at $78,170, an increase over 1908 of 7,976 tons in quantity and $8,190 in value. The producing concerns were the Nicholls Chemical Company, whose mine and acid works are situated at Sulphide, Hastings county, the Northern Pyrites Company, who have begun shipping ore to the United States from an extensive deposit at Lake Minnitakie, near the junction of the branch of the Grand Trunk Pacific railway from Fort William with the main line, and the Northland Mining Company, whose deposits are at Rib lake, on the T. & N.O. railway, Temagami Forest Reserve.

The production of pyrite has been increasing during the last five years, as the following table shows:—

Table XI.—Production of Iron Pyrites, 1905 to 1909

Schedule.	1905.	1906.	1907.	1908.	1909.
Pyrites shipped ....tons	7,325	11,090	15,755	20,970	28,946
Value of do .... $	21,885	40,583	51,842	69,980	78,170
Workmen employed ....No.	68	128	137	132	132
Wages paid .... $	27,690	57,580	75,365	95,740	104,687

The preponderance of wages paid over value of output during the last four years is to be explained by the very considerable amount of preliminary or development work required in order to place some of the deposits in condition to ship, wages for construction as well as for mining being charged against the operations.

Mica

The amber mica of Ontario and Quebec is held in high repute because of its flexibility, thin-splitting properties and general suitability for use in the manufacture of electrical apparatus, the chief purpose for which mica is now employed. Returns to the Bureau show that there were produced in the Province last year 350 tons of rough-cobbed mica, valued at $73,124. There was not much change from the production of 1908, when 368 tons were reported, worth $73,586.

The largest producer was the Loughboro Mining Company. The Kingston Feldspar and Mining Company, Kent Bros. and J. M. Stoness, and Rinaldo McConnell, also contributed to the total. The mines of these companies and firms are in eastern Ontario, for the most part in Frontenac and Lanark counties; but in the districts of Parry Sound, Muskoka and Nipissing, scattered deposits are found in Laurentian rocks, which are occasionally worked in a tentative or experimental way. The mica from these districts is of fair quality, but owing to its being spotted with "iron stains," it is not regarded with the same favor as the product of standard mines in the older regions.

Salt

From the salt wells of the south-western peninsula there were produced last year 77,490 tons of salt, valued at $389,573. The operators were: The Canadian Salt Company, Windsor; Empire Salt Company, Sarnia; Western Canada Flour Mills Company, Goderich; John Ransford, Stapleton, Ontario; People's Salt and Soda Company, Kincardine; Western Salt Company, Mooretown; The Grey, Young and Sparling Company, Wingham; Exeter Salt Works, Exeter; Parkhill Salt Company, Parkhill; and Elarton Salt Works Company, Warwick.

There were employed in the industry 176 men, to whom wages were paid amounting to $89,995.

Petroleum

The petroleum wells of Ontario last year yielded 14,723,105 Imperial gallons of oil, valued at $559,478. The quantity given is that returned to the Department of Trade and Commerce, Ottawa, for purposes of the Dominion Government bounty of 1½ cents per Imperial gallon, and is furnished by the kindness of that Department. This is a decrease of 3,756,442 gallons, as compared with the production of 1908, or 25 per cent.

The decline in the oil yield, which has been commented on in previous Reports, continues to manifest itself in the records of production. There was a diminution in the output of every one of the fields, but the rate of decline in the newer districts of Tilbury and Romney was greater than in the older districts of Petrolea and Oil Springs. Already the production has sunk to less than one-half of what it was fifteen years ago, and if the falling-off is maintained the supply of domestic petroleum will tend to become relatively insignificant, unless new reservoirs are opened up. Even now more

crude oil is imported into the country than is produced here. The fields of Lambton county have already bad great longevity, and are unique among the oil-producing regions of the world, because of the small individual production of the wells, which is only a few gallons a day, and of the economy with which they are operated. Being of shallow depth, many wells may be worked by one engine on the "jerker" system, and so give a profit, which if not large is constant.

Mr. W. J. Harvey, supervisor of crude petroleum bounties for the Dominion Government, furnishes a statement of the production in 1909 by fields, which is here reproduced, along with similar figures for the three preceding years:—

Table XII.—Petroleum Production by Districts, 1906 to 1909

Field.	1906.	1907.	1908.	1909.
	bbl.	bbl.	bbl.	bbl.
Lambton	377,286	304,212	265,368	243,123
Tilbury and Romney	106,992	411,588	201,283	124,003
Bothwell	44,827	42,727	39,228	38,092
Leamington	39,652	6,133	9,334	5,929
Dutton	19,376	14,977	13,743	9,513
Thamesville	175	237	....	....
Comber	651	....	....	....
Total	588,962	779,876	528,959	420,660

As will be seen from the above statistics, the reduction in the yield of the respective fields was as follows: Lambton 22,245 bbl.; Tilbury and Romney 77,280 bbl.; Bothwell 1,136 bbl.; Leamington 3,405 bbl., and Dutton 4,230 bbl.

The average price for Petrolea crude during the year was about $1.33½ per bbl. It opened in January at $1.44 per bbl., at which figure it remained until May 4th, when it dropped to $1.39. On May 11th it fell again to $1.34, on June 25th to $1.29, on July 16th to $1.26, and on October 21st to $1.24, at which it closed the year. The price of Tilbury crude is on a parity with that of Petrolea, but freight by rail to Sarnia from the shipping points must be allowed for. At the beginning of the year the price at Tilbury was $1.27 per bbl. It dropped on May 4th to $1.22, on May 11th to $1.17, on June 25th to $1.12, on July 16th to $1.09, and on October 21st to $1.07, at which figure it remained until the end of the year. The average for Tilbury oil for the twelve months was perhaps $1.16 per bbl. These prices are irrespective of the Dominion Government

The refineries, of which there are two in Ontario, the Imperial Oil Company's at Sarnia, and the Canadian Oil Companies' at Petrolea, distilled a total of 35,530,918 gallons of crude last year. Of this, 16,015,527 gallons, or 45 per cent., was domestic, and 19,515,391 gallons imported.

The following statistics covering five years ending with 1909 show the quantity of crude oil distilled annually and the quantities and value of the several products. It will be seen how the production of domestic crude has steadily gone down during the period covered by the table with the exception of 1907, the first full year for the Tilbury-Romney field:—

Table XIII.—Petroleum and Petroleum Products, 1905 to 1909

Schedule.		1905.	1906.	1907.	1908.	1909.
Crude produced	Imp. gal.	22,131,650	19,998,327	27,621,855	18,479,547	14,723,105
Crude distilled	"	33,821,998	36,134,349	34,961,706	34,675,129	35,530,918
Value crude produced	$	898,547	761,540	1,049,631	703,773	559,478
Value distilled products	"	2,196,678	2,506,177	2,568,462	2,347,680	2,501,384
Illuminating oil	Imp. gal.	16,433,588	16,125,450	18,319,233	17,604,920	17,902,254
Lubricating oil	"	3,402,977	4,351,818	3,931,767	3,384,940	3,856,778
Benzine and naphtha	"	2,827,971	3,497,954	4,132,239	3,667,997	3,930,691
Gas and fuel oils and tar	"	5,788,351	5,961,834	5,632,608	4,461,186	4,687,588
Paraffin wax and candles	lb.	4,077,610	5,011,467	5,132,394	5,400,003	7,092,278
Workmen employed	No.	469	496	435	430	436
Wages paid	$	280,701	308,986	265,316	247,829	261,014

Natural Gas

The production of natural gas has much increased of late years. In value it amounted in 1909 to $1,188,179, an increase over the yield of 1908 of $199,563, and being the largest output yet recorded. For the last four years the quantity produced has been as follows: In 1906, 2,534,200 thousand cubic feet; in 1907, 4,155,900 thousand; in 1908, 4,483,000 thousand; and in 1909 (say) 5,388,000 thousand cubic feet.

The output comes from three fields, namely: Welland county, Haldimand and Norfolk counties, and the counties of Essex and Kent. The Haldimand-Norfolk field is the largest producer. The people of these districts, and of the cities, towns and villages outside of the actual gas area to which it is piped, enjoy a great boon in the use of natural gas for fuel purposes. It is an ideal fuel. It is cleanly, leaving no ashes and producing no smoke; it can be turned on when wanted and turned off when its work is done, thus eliminating waste entirely to the careful user; and it is much cheaper than either coal or wood. The possession of natural gas is an important advantage for the householder as well as to the manufacturer, though it seems a pity that a fuel so suitable for domestic use could not be preserved for that purpose only; and as the quantity, no matter how large it may be, is in any field limited, it is naturally an object of prime importance to the people in that field to conserve the supply to the utmost. To assist in doing so, the Legislature in 1908 passed an Act to Prevent the Wasting of Natural Gas and to Provide for the Plugging of all Abandoned Wells (7 Edward VII., chapter 47), by which power was conferred upon inspectors appointed under the Act to enforce the stoppage of waste. The Supplementary Revenue Act, 1907, also contained provisions which were even more effective than those of the above mentioned Act, and the enforcement of these laws has reduced the waste of gas to a minimum. Probably not less than 200,000 people in Ontario are now using natural gas, and extensions of pipe systems, etc., are now in progress, which will result in a large increase in this number. From the Haldimand-Norfolk field gas is piped to Hamilton, Dundas, Galt, Brantford and other places; the Welland field supplies St. Catharines, Niagara Falls, Bridgeburg and other towns and villages; and from the Kent-Essex field people in Chatham, Leamington, Blenheim and elsewhere are supplied. Franchises have been obtained by the Volcanic Gas and Oil Company from the city of Windsor and the towns of Walkerville and Sandwich, and gas is to be delivered in these places from the Kent field by 1st December, 1910.

The principal gas-producing concerns are the following: In Welland, Provincial Natural Gas and Fuel Company, Buffalo, N.Y.; United Gas Companies, St. Catharines; Port Colborne-Welland Natural Gas and Oil Company, Port Colborne; Welland County Lime Works, Port Colborne; Bertie Natural Gas Company, Ridgeway; Ontario Iron and Steel Company, Welland; Sterling Natural Gas Company, Port Colborne; Empire Limestone Company, Buffalo, N.Y.; Industrial Natural Gas Company, Welland; in the Haldimand-Norfolk field, Dominion Natural Gas Company, Pittsburg, Penn.; Producers' Natural Gas Company, Hamilton; Norfolk Gas Company, Port Dover; Selkirk Gas and Oil Company, Selkirk; Dunnville Gas Development Company, Dunnville; and in the Essex-Kent field, Volcanic Oil and Gas Company, Niagara Falls; Beaver Gas and Oil Company, Leamington; Maple City Oil and Gas Company, Chatham; and Leamington Oil Company, Detroit, Mich.

The Essex-Kent and Haldimand-Norfolk gas fields are proven to the edge of Lake Erie in both cases, and a natural inference was that the gas-bearing territory would be found to extend under the waters of that lake. A number of leases have been granted by the Crown authorizing the sinking of wells for gas and oil on parts of the lake bed in front of Rainham, Walpole, Charlotteville, Romney, Tilbury East and Woodhouse townships. Good wells have been found on several of these leases and a corresponding addition has been made to the gas-yielding area.

Messrs. John Scott of Petrolea and Donald A. Sharpe of Welland are inspectors of oil and gas wells under the provisions of 7 Edward VII., chapter 47. The latter was appointed in succession to Mr. John Toyne, who resigned towards the close of tbe year. Mr. Scott's duties are in Lambton, Essex and Kent counties, while Mr. Sharpe looks after the counties of Haldimand, Norfolk and Welland.

Mr. Scott reports that 546 oil wells were abandoned and plugged, and that there are 518 wells which require to be bailed. The latter call for a good deal of attention, as it is necessary to test the casing frequently, and if any are found leaking fresh water they are abandoned and plugged. Some 129 wells are not being operated, which will require plugging if pumping operations are not begun. There is little trouble with gas wells or lines.

Mr. Toyne reports that much of his time was occupied in looking after the gas wells being sunk on the shore of Lake Erie in order to see that they were properly protected from the effect of rough weather and ice, which might possibly lead to the introduction of water into the gas-bearing strata. There is no oil in this field, and the complications which occasionally follow the presence of both in the same wells were therefore absent.

Mr. G. R. Mickle, M.E., in the performance of his duties as Mine Assessor, has charge of the collection of the tax on natural gas and also the direction of the movements of the gas and oil well inspectors. Under the heading of Mining Revenue, Mr. Mickle makes some interesting remarks regarding gas and oil.

Minor Products

In the varied list of mineral products of Ontario are a number of substances useful in the arts, which though not produced in large quantity, are yet the basis of industries of some importance, most of which could be greatly extended if necessary. These are enumerated below.

Calcium Carbide

Calcium carbide is made by two companies, the Willson Carbide Company, Merritton, and the Ottawa Carbide Company, Ottawa. Together they produced 2,349 tons in 1909 as compared with 2,364 tons in 1908. The principal use of calcium carbide is, of course, the production of acetylene gas for illumination purposes, for which it finds considerable employment in small or isolated places where ordinary lighting gas is not available.

Corundum

The production of corundum, which had been discontinued by the largest operating company in 1908, was resumed last year, and 1,508 tons of this mineral, crushed and graded to size, were turned out during the twelve months. The Manufacturers' Corundum Company, lessees of the works of the Canada Corundum Company, Craigmont, and the Ashland Emery and Corundum Company, Burgess Mines, were the producers.

The chief employment of corundum continues to be for abrasive purposes, for which it is eminently suitable, though in certain special uses it has to compete with such substances as carborundum, an artificial compound made by fusing silica and carbon in the electric furnace, also with garnets, etc. Notwithstanding its high contents of aluminium, no feasible method has yet been brought forward of reducing this metal from corundum.

Feldspar

The business of producing feldspar was not very brisk last year, the demand being somewhat inactive. The quantity produced, however, was 11,001 tons as against 7,875 tons in 1908. Prices remained at about the same level. The production came entirely from the quarries in the neighborhood of Verona station on the Kingston and Pembroke railway, Frontenac county, operated by the Kingston Feldspar and Mining Company and the McDonald Feldspar Company. The latter is a newcomer into the field, the president being Mr. R. R. Gamey, M.P.P.

The product is shipped entirely to the United States, where it is used in the manufacture of porcelain goods and enamelled ware. The superior qualities of the Ontario feldspar enable it to compete with the product of the United States quarries, and to obtain a price which will pay for the long haul to the potteries of Newark, N.J., and East Liverpool, Ohio. So far the attempts made to export feldspar to England have not been successful, ocean freights being so uncertain as to make it difficult to quote prices delivered.

Graphite

Two deposits of graphite were worked last year, one by the Black Donald Graphite Company on Whitefish lake, fourteen miles from Calabogie, Renfrew county, and the other by the Globe Refining Company in the township of North Elmsley, in the county of Lanark. At both mines there are works for treating the graphite, the output of both plants being 730 tons of the refined product, valued at $37,624. At the Black Donald property mining is carried on for about three months in the year only, but the mill is kept in operation all the time. None of the crude product is marketed as such, refined graphite only being shipped and sold to the trade.

Mr. B. F. Bunting, general manager of the Black Donald Company, states that of the output of the mill about 25 per cent. consists of crystalline flake graphite, while the other three-fourths comprise various grades of what are termed "powdered plumbago." No. 1 flake is used for lubricating purposes, and also in the manufacture of crucibles, while Nos. 2 and 3 flakes are employed principally for the lubrication of high-speed engines. Of the powdered plumbagos the lower grades are used for foundry facings, etc.; the better qualities for stove polish, electrotyping, graphite structural iron paint, and many other purposes. The bulk of the company's output is marketed in the United States, the Canadian demand being limited. European shipments have been tried, but the time consumed in making delivery and red tape in forwarding consignments make the business somewhat unsatisfactory. The mill is operated by electricity generated at the Madawaska river, two miles away, each department of the mill being operated by an individual motor. Some prejudices against Canadian graphite product have had to be met by the company among United States consumers, due to inferior and badly-prepared goods having previously been thrown upon that market, but this difficulty is now disappearing. Mr. Bunting adds that the refining of graphite has baffled many experimenters both in this country and in the United States, and that successful refiners guard their processes carefully as trade secrets.

Gypsum

The production of gypsum is confined to the valley of the Grand river in the neighborhood of Paris, Caledonia and Cayuga, where deposits occur in the Onondaga limestone. The Alabastine Company of Paris and the Imperial Plaster Company of Toronto were the only producers, raising and shipping some 11,488 tons of crude gypsum. By the former company the raw material is worked up into a variety of products, including alabastine, wall plaster, bug poisons, etc.; and by the latter it is used, along with wood fibre, to produce an article called by the latter name, and used for construction purposes.

Peat Fuel

Peat fuel was made to the extent of about 60 tons by J. McWilliam, M.D., at a plant in the township of North Dorchester, Middlesex county. Dr. McWilliam reports: "We spent the whole season putting in new machinery and collected 600 tons of dust, but only pressed about 60 tons, when the frost got too much for us."

High hopes have at various times been entertained of a successful solution of the problems presented by the manufacture of an acceptable fuel from peat, and many promising attempts have been made to realize these hopes. The crux of the question undoubtedly lies in the removal of the moisture, of the retention of which peat is ex-

tremely tenacious. If artificial heat must be resorted to for this purpose, the cost is usually raised to a point at which the resulting fuel is unable to compete with coal, regard being had to the calorific value of each. Probably the most hopeful method of utilizing the fuel value of peat is by the producer gas process, but this puts it out of the field of domestic fuels, and restricts its employment to manufacturing or industrial plants which can be located near the bog from which the peat is taken. An immense quantity of carbon is lying dormant in the peat bogs of Ontario, and there is little doubt that some day an efficient fuel will be produced from them. It may not be, however, until coal and wood are higher in price than they now are.

Apatite

Phosphate of lime, or apatite, was mined in Ontario and Quebec in considerable quantities a good many years ago, but the lower grade and cheaper phosphates of the Southern States drove it from the market, and it has not since found a re-entrance in any quantity. In 1908 some 881 tons were reported as mined in Ontario, but last year the production fell to 272 tons. It is not improbable, however, that Canadian phosphate may come again into demand. It is frequently found in conjunction with deposits of mica.

Talc

A promising industry has been established at Madoc by Messrs. George H. Gillespie and Company in the grinding and preparation of talc for the market. Several grades of product are turned out, differing in fineness, and adapted to a variety of uses, such as the manufacture of cosmetics and soaps, paper filling, leather dressing, etc. The raw material, which is of fine quality, is obtained from a deposit in the township of Huntingdon, Hastings county, some 4,350 tons having been raised last year.

Quartz

The output of quartz last year amounted to 63,172 tons, valued at $75,329, as against 44,741 tons, worth $52,830, in 1908. The principal production was by the Canada Copper Company and the Mond Nickel Company for furnace linings. A considerable quantity was also raised by the Lake Superior Power Company, and by the companies mining feldspar in Frontenac county. In quarrying the feldspar, dikes of quartz are encountered, which are broken up and removed, the material being kept separate from the spar.

A Glass Sand Area at Amherstburg

Rev. Thomas Nattress, B.A., of Amherstburg, Ont., who has already contributed to the Bureau much useful information regarding the geology of the stratified rocks of Essex county,[5] gives the following description of an outcrop of Sylvania sand-rock at Amherstburg. Glass manufacturers and others who are interested in a supply of nearly pure silica free from discoloring agents might with profit investigate this occurrence.

In the bed of Detroit river, at Amherstburg, Ontario, immediately on the south side of the town, there is a surface extension of Sylvania sand-rock the full breadth of the channel between Bois Blanc island and the main shore of Essex county.

On the south end of Bois Blanc it pumps up with the water in one or two wells put down by the Detroit, Belle Isle and Windsor Ferry Company on their park property.

Ashore, in the Dr. Green shaft on the Point Farm on Elliott's Point, it lies under 25 feet of Silurian dolomite, and has there been tested by the drill to a depth of seven feet. A hundred yards east of this a deeper test was made by the late Mr. Fred Elliott to a depth of 14 feet without penetrating the deposit. In rear of the next farm south of the Point Farm the sand is 84 feet in depth (Brumell) under 228 feet of rock. At the rear of the third farm north of the Point Farm there is 60 feet of it under 252 feet of other rock (Brumell).

These farms are in Malden township. In the adjoining township of Anderdon, some seven or eight miles north-east from the Dr. Green shaft at Elliott's Point, there is a depth of 30 feet of Sylvania sand-rock under 350 of limestones and dolomites.

In No. 11 C.P.R. salt well at Windsor there is 55 feet of it under 535 feet of dolomites and limestones.

[5] 11th Rep. Bur. Min., 1902, pp. 123-7; ditto, 1904, Part II., pp. 41, 42.

Across the river from here, at the salt shaft at South Detroit, there is a depth of 117 feet of it under 63 feet of Dundee (Corniferous), 189 feet of Lucas dolomite, 38 feet of problematical limestone, and 47 feet of Flat Rock dolomite.

At Wyandotte there are 60 feet of Sylvania under 50 feet of Dundee (Corniferous) and 105 feet of dolomite.

And in the extreme south-east corner of Wayne County, Michigan, immediately opposite Elliott's Point, there is an outcrop of it. Thence the deposit extends across Monroe County into north-western Ohio, past the village of Sylvania, whence it is named.

The Sylvania is a pure glass sand. It has been variously described in equivalent terms as 99 per cent. silica,[6] minute loosely cohering grains of quartz,[7] etc. It is altogether free of iron, except where an oxydized surface has been exposed to the effect of some piece of iron ore from the cargo of a passing steamer.

Sylvania sand-rock has been thought by several authorities to be the equivalent of the Oriskany sandstone of New York State. It has, however, a lower and altogether independent horizon, equivalent as it may be in quality, properties and utility. There is sufficient local evidence, on both sides of Detroit river, to enable identification of the Oriskany at the base of the Corniferous—where it has always been stated by New York geologists to belong; whereas the Sylvania lies deeper than upper Silurian beds, which are characterized by "gypsum, and most of the strontianite and celestite"[8] of the dolomite beds.

In addition to its use as a glass sand of tested utility, found to be of excellent quality for that use even where (as in Monroe County river-bottom and river-bank exposure), it requires to be washed, the Sylvania, like the Oriskany, is available for use in the manufacture of cleansing compounds. Also, as at the Buffalo pottery, in the packing of pottery for firing.

Experiment has been made locally in the use of the sand in the manufacture of artificial stone. Alone, however, it is too sharp a sand for this purpose. To avoid the excessive use of cement, and thus preserve the desired whiteness in the finished product, it would be necessary to combine marble dust, etc., with the sand.

The most accessible part of the deposit is the river bottom at Amherstburg and the shaft at Elliott's Point.

The same sand has been extensively imported into Ontario for glass purposes.

It remains but to say that the irregular, loop-shaped contour of the Sylvania in the Detroit river area is accounted for by observing that the Cincinnati anticline extends considerably farther north than hitherto mapped by Schuchart, or described by Ohio or Michigan geologists.

Mining Revenue

Receipts from mining sources for the ten months ending 31st October, 1909 (the fiscal year having been changed), amounted to $979,464.15, made up as below. For the calendar year 1908 the receipts were $549,178.94.

1. On account of mining land sales	$235,098 04
2. do do do leases	19,016 74
3. Miner's licenses, permits and fees	219,473 95
4. Mining royalties	338,126 66
5. Supplementary Revenue Act	49,730 03
6. Provincial mine (including sale of)	115,411 71
7. Diamond drills	1,517 42
8. Provincial Assay Office	789 60
Total	$974,464 15

The following explanations are made with regard to the several items of receipts, with the view of making clear the working of the law in the obtaining of a revenue from the mining lands of the Crown.

Mining Lands

Details of mining lands disposed of during the ten months are given in the following table, which has reference to the transactions carried out during the period, but is not confined to moneys actually received within the ten months. The totals for Sales and Leases, therefore, do not agree with the figures given above, which include the sums received at the Department between 1st January and 31st October, and nothing else. In the case of mining leases, much rental paid on previously issued leases is comprised.

[6] Solvay Process Company, South Detroit. [7] Geological Survey, Ottawa.
[8] Sherzer, in 1899 Michigan Geological Survey, on Monroe County.

Table XIV.—Mining Lands Sold and Leased in 10 Months Ending 31st October, 1909

District.	Sales.			Leases.			Total.		
	No.	Acres.	Amount.	No.	Acres.	Amount.	No.	Acres.	Amount.
			$ c.			$ c.			$ c.
Nipissing	286	8,659.41	358,408 69	50	2,511.03	2,511 03	336	11,170.44	360,919 72
Thunder Bay....	3	240.00	660 00	.....	....	......	3	240.00	660 00
Sudbury	4	146.75	440 31	2	709.61	709 61	6	856.36	1,149 92
Algoma	5	1,309.06	3,271 53	1	75.00	75 00	6	1,384.06	3,346 53
Kenora	5	144.10	360 25	.....	....	....	5	144.10	360 25
Rainy River	3	120.00	360 00	......	....	....	3	120.00	360 00
Elsewhere	4	90.00	135 00	......	....	....	4	90.00	135 00
Total	310	10,709.32	363,635 78	53	3,295.64	3,295 64	363	14,004 96	366,931 42

The mining leases that are now being issued are mainly for lands in the Temagami Forest Reserve, in which part of the Elk Lake silver camp and the whole of the Gowganda region are situated. The Mining Act forbids the sale of lands for mining purposes in a forest reserve, the idea, no doubt, being that when the leases fall in, as many of them probably will should the lands prove unremunerative in working, the Crown will again be in control of the territory and can use it for the growing of timber. A few leases are still being granted on old applications under the Act of 1897.

It will be observed that the lands disposed of were practically confined to the district of Nipissing, in which are situated the silver fields of Cobalt, South Lorrain and Gowganda. The acreage sold or leased in other parts of the Province was not greater than usual.

The Gillies Limit

Sales are a much heavier item than in 1908. This is accounted for by the fact that a small portion of the tract known as the Gillies Limit was subdivided into parcels of convenient size and sold by public tender. Details of the several sales are given below.

The Gillies Timber Limit lies on both sides of the Montreal river and covers an area of 100 square miles, being approximately 10 miles square. Its southeastern boundary comes to about 10½ miles from the mouth of the river, to the course of which and also of the western shore of lake Temiskaming, the limit extends in a parallel direction upstream. The situation of the Gillies Limit is indeed dependent upon the position of the shore of the lake, being laid out with its northeastern boundary five miles distant from the lake. Lumbering operations have been carried on in the limit for many years, in fact more or less continuously ever since the right to cut the timber was bought from the Crown in 1852, and a good deal of the pine has been removed. Nevertheless, parts of the berth have never been cut over, and there is still standing not only considerable green pine but also large quantities of cedar, spruce, jack-pine and the other varieties of timber characteristic of the northerly forests of the Province. The existence of a valuable tract of virgin pine in the extreme northeastern angle of the limit, within two or three miles of the present town of Cobalt, and the fear that it might be endangered by fire, led to the land being withheld from staking out for minerals when the discovery of the rich silver veins from the Cobalt camp were attracting hundreds of prospectors to the neighborhood. Later, the Government decided to prospect the area for minerals with the view of utilizing the deposits, if any should be found, to the best advantage for the public.

Accordingly, the Legislature having appropriated the necessary funds, the exploration of the limit was begun by the Bureau of Mines in the spring of 1906, Professor W. G. Miller, Provincial Geologist, being in charge of the work. There were rumors regarding the fabulous wealth of the Gillies Limit, and circumstantial reports were current of veins having been found of a size and richness to out-Cobalt Cobalt. Rewards were offered for the disclosure of such finds, and much time and labor was con-

sumed in endeavoring to locate the veins on the ground when the alleged discoverers could be induced to support their tales by heading a search party. Not an atom of truth was found to exist in any of the "discoveries," and the only veins found upon the limit were those disclosed by the labors of the Government prospectors.

Naturally, the area nearest the known deposits of the Cobalt camp was first examined. In 1906 between three and four miles of trenches were dug, bed rock being covered in many places with gravel and boulders from one to five or six feet thick. Several veins were found, the most promising being one exposed while trenching by two prospectors named Brown and McLaren in the Government's employ. A standing reward of $150 per inch in width for valuable silver-bearing veins served to stimulate the vigilance and exertions of the trenchers, and as the vein was seven inches wide at the surface, Brown and McLaren divided between them a bonus of $1,050. Upon this vein it was determined to sink, and the opening came to be called the Provincial mine. A shaft was sunk to a depth of 140 feet, and levels run at 65 feet and 125 feet, at the first level drifts being driven east 350 feet and west 250 feet respectively. In 1908 another shaft was put down near the eastern boundary of the property to a depth of 70 feet, and in 1909 a diamond drill was employed to test the vein. Neither here nor in the main shaft, however, was any large body of rich ore located. Several other veins were found, one near the T. & N.O. railway track opposite the Morrison or Red Jacket claim, and one or two in the vicinity of Giroux lake, but silver in paying quantity did not appear to be present in any. The whole of the area comprised within the limit was examined in a general way, but nothing further was observed which appeared to warrant trenching or sinking. The geology of the whole was, however, carefully worked out, and the tract surveyed into blocks containing 640 acres each, for convenience in any future operations.

Four sales were held in all, namely, on 15th June, 13th July, 13th September and 15th November, 1909, after due advertisement by circular and in the newspapers. At the first sale 11 parcels containing 213.99 acres were sold for $47,085; at the second, 13 parcels containing 208.54 acres for $49,211.50; at the third, 20 parcels or 448.90 acres for $127,082.50; and at the fourth, 37 parcels or 870 acres, for $488,079.60; in all, 81 parcels containing 1,671.71 acres for $711,458.30. The last sale took place after the expiry of the ten months' fiscal period, and consequently only the amounts paid in connection with the first three sales are included in the receipts given above. The conditions of sale provided for an expenditure of $20 per acre per annum for seven years in stripping or opening up mines, sinking shafts, or other actual mining operations, not including the construction of houses, roads, or other like improvements. A royalty of ten per cent. was also reserved to the Crown on the gross proceeds (less freight and smelter charges) of all ores, metals and minerals taken from any of the lands, so that if workable deposits are found, a reasonable share of the profits will be obtained for the public benefit.

It will be noted that the prices obtained at the last sale were much better than at either of the first three; this is no doubt due to the fact that on parcel A. 22, purchased by Mr. J. H. Waldman of Montreal at the first sale, a vein was found after vigorous trenching which showed native silver, and which was traced across the boundary of the location to parcel A 23, bought by Mr. G. E. Martel of Renfrew. This vein shows much similarity to that upon which the shaft at the Provincial mine was sunk.

Miners' Licenses, Permits and Fees

The receipts from the sale of miners' licenses, permits for prospecting in the Temagami Forest Reserve, and fees for recording claims, transfers, etc., were much in excess of those for the year 1908, being $219,473.95, as against $137,730.20. The charge for a miner's license, which is required in order to stake out mining claims on Crown lands, is $5 for an individual; for an incorporated company the fee varies according to the amount of the capital stock, being $25 for a capital not exceeding $40,000; $50 for a capital over $40,000, but not exceeding $100,000; $75 for a capital over $100,000, but

not exceeding $500,000; $100 for a capital over $500,000, but not exceeding $1,000,000; and for each additional $1,000,000 or fraction thereof $100. All licenses expire on the 31st day of March next after the date of issue, and if any unpatented mining claim depends upon the validity of a license, it must be renewed on expiry. Licenses issued after the first day of October are charged for at half rate.

The demand for miners' licenses naturally varies with the activity in prospecting for minerals, and this in turn depends to a large extent upon the discovery of new mineral fields and rich deposits. There has been a succession of such discoveries during the last few years. The finds at Cobalt beginning in 1903 and extending throughout 1904, 1905 and 1906 were so extraordinary that a large army of prospectors was attracted to the field, and these were followed by the striking of rich silver ores on the banks of the Montreal river, in South Lorrain and Gowganda. The nickel field in Dundonald and Clergue was located during 1908, and even restricted, as it apparently is, the possibility of another Copper Cliff or Creighton mine being hidden under the drift of that locality is sufficient to draw prospectors into the district. Then in 1909 the "gold dome" and other gold-besprinkled quartz shows at Porcupine lake turned the attention of hundreds of prospectors to this newest of Ontario camps. Still later, a rush was precipitated while the snow was yet on the ground by a rumor that the Porcupine finds had been equalled or excelled by discoveries at Caribou, or Camel's Back lake, situated west of the T. & N.O. railway on the Wataybeeg route. A considerable number of prospectors were attracted to the spot, many of them being taken by special train to Burk's Siding, only to find that the report was a hoax. There is so much unexplored territory in Northern Ontario, and so large a part of it is occupied with rock formations favorable to the occurrence of minerals, that further discoveries will inevitably be made, and the prospector kept busy for many years to come.

The fee for a permit to search for minerals in a forest reserve is $10, the permit being for twelve months. The presence of a large number of prospectors in a coniferous forest beyond doubt constitutes a danger to the safety of the trees through the introduction of fire. It is necessary, therefore, during the dry season of the year to maintain a large force of fire rangers to prevent, if possible, the occurrence of fires, and to assist in their extinguishment, should fires occur. The expense of maintaining this fire patrol is much greater than the revenue derived from the issue of Forest Reserve permits.

Mining Royalties

There was received during the ten months from mining royalties the sum of $338,426.66, as follows:—

Crown Reserve Mining Company	$145,437 46
O'Brien Mine	141,497 15
Temiscaming and Hudson Bay Mining Company	44,403 26
Chambers-Ferland Mining Company	7,088 79
Total	$338,426 66

The Crown Reserve pays a royalty of 10 per cent. of the value of the ore at the pit's mouth, this being one of the conditions of purchase from the Crown. The O'Brien mine contributes on a basis equal to 25 per cent. of the receipts from sales of ore, less a proportion of surface expenses, and there is a similar arrangement with the Chambers-Ferland Company. The Temiskaming and Hudson Bay Company pay at the rate of 15 per cent. of the net receipts.

The accruals on account of royalty for the calendar year 1909 were as follows:

Crown Reserve Mining Company	$160,437 46
O'Brien Mine	141,497 15
Temiscaming and Hudson Bay Mining Company	52,263 62
Chambers-Ferland Mining Company	16,259 64
Total	$370,457 87

Of this amount only $338,426.66 fell due and was paid within the fiscal period.

Up to 31st October, 1909, there had been received by the Department in mining royalties an aggregate of $779,443.68, as follows:

O'Brien Mine	$474,357 52
Crown Reserve Mining Company	174,695 31
Temiscaming and Hudson Bay Mining Company	123,302 06
Chambers-Ferland Mining Company	7,088 79
Total	$779,443 68

In the case of sales of land on the Gillies Limit, a condition of the grant is the payment of a royalty of 10 per cent. on the returns from the ores extracted. No shipments were made in 1909 from any of the locations on the limit.

Supplementary Revenue Act 1907

The receipts derived under the provisions of the Supplementary Revenue Act, 1907, during the ten months ending with October last, were $49,730.03, made up as follows:—

Profit tax	$28,812 60
Acreage tax	10,719 85
Gas tax	10,197 58
Total	$49,730 03

Owing to the change in the fiscal period the receipts falling within the ten months are much less than they were for the calendar year 1908, the taxes imposed by the Act not being payable until the first day of October.

Mr. G. R. Mickle, M.E., Mine Assessor, who is charged with the duty of ascertaining the amount due as taxes under this Act and collecting the same, supplies the following information regarding the working of the law for the year 1909. It will be observed that Mr. Mickle's figures are for the full calendar year, not for the ten months' period only.

This Act imposes three taxes, viz.: (1) Profit tax, being a levy of three per cent. annually on all profits of mines in excess of $10,000.00. The method of arriving at the profits is set out in full in the Act, certain deductions being made for income tax paid the municipality in which the mine is situated. (2) An acreage tax of two cents on all lands patented or leased as mining lands which are in territory having no municipal organization. (3) Natural gas tax of two cents per thousand cubic feet, 90 per cent. of this being rebated if the gas is used in Canada.

The results for 1909 were as given below. The amounts due under this Act are not payable till October 1st, and it has been found impracticable to collect all payments before the 31st of October (the end of the fiscal year of the Province at the present time). The statement given here, therefore, does not agree with that which takes into account only payments made within the fiscal year.

The total amount received as taxes due for the year 1909 was $101,951.49, distributed as follows:—

(1) Profit tax	$78,327 58
(2) Acreage tax (15th April, 1909, to 15th April, 1910)	10,777 55
(3) Natural gas tax	12,846 36
Total	$101,951 49

The acreage tax is paid at all times throughout the year, sometimes several years' tax being paid at once. No effort has been made to keep the tax belonging to any year separate. The amount given shows the payments made during the period. It will include most of the 1909 tax.

With regard to the first, the profit tax, this was received from fifteen different companies, most of which are in the Cobalt district. Those companies which pay a royalty under separate agreements with the Crown are not required to pay the profit tax, and this reduces the amount accruing under the tax considerably. The amount would be greater by about $26,800 if those companies paying a royalty had been on the same basis as the others.

Outside of Cobalt, two companies operating nickel-copper mines in Sudbury district paid a profit tax, and also one company producing iron ore. If the iron ore is treated

in domestic furnaces the tax is remitted. As the price paid for iron ore in Canada during 1908 (the year on which the tax is based) was good and the demand brisk, very little ore was exported, and the tax dropped to a small amount.

No reason is visible for anticipating any substantial change in the revenue from this source during the next two or three years; probably some revenue will be derived from pyrites mines. It is too soon to say whether any considerable revenue may be expected from gold mines.

The operation of the acreage tax was explained fully in last year's report. Briefly stated, about 800,000 acres in the Province are liable for this levy, the greater part of this being situated in the northwestern part of Ontario, where the land was taken up in large blocks, many containing 400 acres and some 6,400 acres. In the northeastern part of the Province, which is younger so far as mining or the acquiring of mining lands is concerned, most of the land has been staked under the Act of 1906; 40 acres is therefore the maximum, and it is not necessary to purchase till three years and six months after staking, provided the work prescribed is done. The number of acres patented, and consequently taxable, is small in this part, considering the activity in mining, only some 14,000 acres of land subject to the tax existing in the whole Nipissing district, extending from the eastern boundary of the Province westward nearly to Sudbury.

As required by the Act, notice was published of all lands two years in arrears for taxes and the time for forfeiture fixed as 30th June, 1910. About 247,000 acres in all are thus in arrears and were advertised in December last; taxes have been paid on 20,200 acres up to date (15th April, 1910). It seems probable that before the time in which payment may be made elapses, the number of acres in arrears will be reduced to less than 200,000.

The natural gas tax was paid by thirty-two different individuals or companies operating in the three fields, viz.: the Welland-Haldimand-Norfolk field, the Kent field south of Chatham, and smaller Essex field. Of the amount paid about 36 per cent. was tax on gas exported or wasted. In the first mentioned field, in which a comparatively thin bed of gas-bearing rock is spread over an area which it is hard to estimate, extending from east to west along the shore of Lake Erie, producing wells are found for a distance of about 60 miles, not continuously, however. Extensions to the west may be found. The extent of the field in a north and south direction is difficult to determine. Undoubtedly it runs under the lake and dies off toward the north, probably three to four miles from the lake shore northwards being the limit. The area would, therefore, be something like 200 square miles, excluding the part covered by the lake. The results of drilling on the leases of the bed of the lake obtained from the Crown have been satisfactory to the operators.

No oil has ever been found in this area and the gas has been well conserved from the start. On 1st April, 1909, exportation of gas from this field ceased entirely. The operation of the Supplementary Revenue Act contributed largely to this result.

In the Kent field the area of gas-bearing rock is smaller, being about 34 square miles. The thickness, however, is greater, so that it forms a very valuable field. Oil is also found in that locality, some even existing in the gas area proper, the gas field being flanked by an oil territory. This has led to a conflict of interests, some of the operators for oil being indifferent to waste of gas. Under the Act gas wasted was taxed at the full rate of two cents per thousand cubic feet. This was sufficient to compel the stoppage of all waste, and to protect the revenue derived from natural gas tax. The Legislature, however, in the session of 1910 passed an amendment whereby waste from a well producing oil in "paying quantities" cannot be taxed except under certain circumstances. This amendment will diminish the revenue derived from gas. The future will show whether there are any substantial compensating advantages from the results of the oil operations in that area.

Provincial Mine

The receipts under this head, $115,411.71, represent the price ($113,111) obtained on the sale of the mine and a few small sums received for rental of power supplied to neighboring properties.

The Provincial mine, consisting of about 30 acres, was put up at tender and disposed of along with other parcels on the Gillies Limit offered on 15th October, 1909. A considerable amount of money had been expended in working the property and in equipping it with machinery. The vein upon which the main shaft was sunk, though showing much native silver at the surface, did not prove persistent or rich in depth, and the

Department had the alternative of spending a further sum, probably a large one, in the endeavor to find payable ore, or of offering the property for sale and permitting private enterprise to supply the capital for the test and reap the benefit should it be successful. After duly weighing the question, the conclusion was reached that it was not wise to risk more of the Province's money in the attempt, but that it was better to sell. It was one thing to work a rich deposit of ascertained value, and quite another thing to adventure the funds of the Province, with results which might be satisfactory or might be unsatisfactory—even such chances as a private company risking its own capital might deem itself in every way justified in taking. In short, while quite willing to work the mine for the benefit of the Treasury, if it had turned out to be a bonanza similar to some of the well-known Cobalt mines farther north, the Department did not deem it desirable to speculate with the Province's funds, notwithstanding the fact that the Legislature had placed them at its disposal.

It may be added that the purchase money not only repaid the Province for all the money spent on the mine proper, but also for all the expenditure in surveying and exploring the limit as a whole Should the Provincial mine prove profitable to its new owners, ten per cent. of the returns will accrue as royalty for the benefit of the public chest.

Diamond Drills

Receipts for rental of the Government diamond drills amounted to $1,517.42. The first of the drills procured by the Department was bought in 1894, and subsequently, in 1900, another smaller one was purchased. Under the terms of the regulations adopted, the drills were loaned to persons wishing to prospect their properties by boring, the Government bearing 35 per cent. of the cost, and the person getting the drill the remainder. A large amount of useful work was done by the drills, but after so long service the parts had become worn, and the machines required extensive repairs or replacement by new ones altogether. In addition, the reason for the Government obtaining the drills and placing them at the service of the public no longer existed in its original force. When they were bought diamond drills were scarce, and it was difficult, if not impossible, for the owner of a mineral prospect who did not himself own a drilling outfit to procure the services of one. Now, however, not only are the mining companies, whose number has greatly increased, provided with as many drills as they deem necessary for their own use, but private contractors stand ready to supply drilling plants and to put down holes, generally at a specified price per foot. Under these circumstances, the Department decided not to renew the drills or continue in the business, and both plants were disposed of, together with the diamonds on hand.

Assay Office

The receipts from the Belleville Assay Office for the ten months, $789.60, are composed of fees received for assays and analyses made for prospectors and others sending samples for examination. The Assay Office also does a large amount of work for the Bureau, and in sampling and assaying shipments of ore on which royalty is payable to the Crown.

Profile

Accompanying the Nineteenth Report will be found a profile of the region from Toronto northerly to the edge of the Paleozoic limestones on the Hudson Bay slope. The profile follows the lines of the Grand Trunk and the Temiskaming and Northern Ontario railways to Cochrane, a distance of 479 miles, thence westerly 32 miles along the National Transcontinental railway to the Mattagami river, which watercourse it descends a distance of about 80 miles. Outliers or isolated areas of Paleozoic limestones occur at lake Nipissing and the town of New Liskeard at the head of lake Temiskaming. The profile shows that these uneroded patches of limestone lie in comparatively deep depressions or valleys of the pre-Cambrian rocks.

Mining Companies Incorporated in 1909

There were 282 mining companies incorporated under the laws of Ontario in 1909, with an aggregate nominal capital of $236,883,000. The record in this respect for the year is intermediate between that of 1908 and that of 1907. Last year the number of companies was 184, having a combined capital of $123,526,500, while in 1907 the number was 321 and the authorized capital $319,876,000.

Last year nine companies of Dominion or foreign incorporation were licensed to carry on business in the Province, as against eight in 1908.

Following is the list:—

Table XV

Name of Company	Head Office.	Date of Incorporation.	Capital Stock.
			$
Alumni Mines Company, Limited	Ottawa	April 7	1,000,000
Arcadia Silver Mining Company, Limited	Morrisburg	August 21	1,000,000
Argo-Cobalt Mines, Limited	Toronto	July 28	1,000,000
Atlantic Silver Mines, Limited	Cobalt	July 12	40,000
Bartlett Mines, Limited	Toronto	January 6	4,000,000
Bateese Mines, Limited	Toronto	January 5	500,000
Bellellen Silver Mines, Limited	Haileybury	November 23	2,500,000
Belmont Silver Mines of Kerr Lake, Limited	Toronto	May 6	2,000,000
Berkshire Mining Company, Limited	Haileybury	March 27	300,000
Big Bear Lake Mines, Limited	Toronto	November 19	40,000
Bison Consolidated Mines, Limited	Haileybury	April 20	2,000,000
Black Mines, Limited	Toronto	April 26	2,000,000
Black Mines Consolidated, Limited	Toronto	August 17	3,000,000
Blairton Iron Mines, Limited	Toronto	January 8	40,000
Boston and Ontario Silver Mines Company, Limited	Toronto	December 1	40,000
Boston Portage Cobalt Silver Mines, Limited	Cobalt	January 29	40,000
Boyd-Gordon Mining Company, Limited	Toronto	January 6	1,000,000
Brewster Mining Company, Limited	Toronto	August 6	10,000
British Canadian Exploration and Mining, Limited	Toronto	April 13	2,000,000
Caledonia Gypsum Company, Limited	Hamilton	December 28	150,000
Canada Pipe and Steel Company, Limited	Toronto	October 29	100,000
Canadian-American Silver Mines, Limited	Toronto	June 2	40,000
Canadian Gowganda Silver Mines, Limited	Toronto	May 14	100,000
Canadian Northern Mines, Limited	Toronto	December 20	1,000,000
Cedar Lake Cobalt and Silver Mines, Limited	Toronto	November 20	1,000,000
Chicago-Gowganda Mines Company, Limited	Toronto	September 21	1,000,000
Chief Matash Mines Company, Limited	Toronto	September 27	500,000
Clawson Silver Mines, Limited	Toronto	July 12	1,500,000
Clinton Mines Company, Limited	Toronto	December 16	1,000,000
Cobalt Delta Mining Company, Limited	Cobalt	March 11	40,000
Cobalt Holding Company, Limited	Windsor	February 11	200,000
Cobalt National Mines, Limited	Toronto	January 6	50,000
Cobalt Paymaster Mines, Limited	Toronto	March 22	2,000,000
Cobalt Wilber Mines, Limited	Toronto	February 24	40,000
Consolidated Oil Fields, Limited	Toronto	November 9	250,000
Crescent Silver Company, Limited	Toronto	March 11	40,000
Crown Majestic Mines, Limited	Toronto	October 1	1,000,000
Crown Star Mines Company, Limited	Toronto	November 16	1,000,000
Detroit Mines, Limited	Toronto	April 21	1,000,000
Diamonds and Gold, Limited	Toronto	February 8	2,000,000
Dominion Limestone Company, Limited	Port Colborne	December 3	50,000
Dominion Metals, Limited	Toronto	September 4	500,000
Dominion Ores, Limited	Windsor	June 29	250,000
Dominion Silver Mines, Limited	Ottawa	February 5	2,000,000
Doric Reserve Mines, Limited	Toronto	August 3	1,500,000
Dreadnought Mines, Limited	Ottawa	May 12	1,000,000
Dufferin Gowganda Mines, Limited	Toronto	January 11	1,000,000
E. B. Wood Cobalt Mines Company, Limited	Cobalt	September 9	40,000
Electric Smelting and Power Company, Limited	Toronto	August 3	4,000,000
Electro Steel Company of Canada, Limited	Toronto	October 15	100,000
Emerald Lake Iron Company, Limited	Toronto	February 22	10,000
Esperanza Syndicate, Limited	Toronto	February 15	40,000
E. T. Mining Company, Limited	Toronto	April 21	1,000,000
Fairplay Mining Company, Limited	Toronto	February 16	500,000
Foley Gold Mines Company, Limited	Fort Frances	April 20	1,000,000
Forest Reserve Silver Mines, Limited	Windsor	November 22	2,000,000
Forty-Six Mining Company, Limited	Haileybury	March 4	300,000
German American Mining Company, Limited	Cobalt	December 21	1,000,000
Gifford Gold Fields, Limited	Toronto	November 20	150,000
Giroux Lake Mines, Limited	Parry Sound	December 30	1,000,000
Gowganda and Montreal River Mines, Limited	Toronto	February 22	1,000,000
Gowganda Belle Mining Company, Limited	Toronto	March 3	2,000,000
Gowganda Centre Silver Mines, Limited	Toronto	January 11	1,000,000
Gowganda City Silver Mines Limited	Toronto	January 19	1,000,000
Gowganda-Cobalt Venture Corporation, Limited	Toronto	March 20	2,500,000
Gowganda Elkhorn Mines, Limited	Chatham	March 29	1,000,000
Gowganda Exploration Company, Limited	Toronto	February 1	100,000
Gowganda 4 Mining Company, Limited	Toronto	May 12	1,000,000

Table XV.—Continued

Name of Company.	Head Office.	Date of Incorporation.	Capital Stock.
Gowganda Mine Producers, Limited	Toronto	June 16	$100,000
Gowganda Native Silver Mining Company, Limited	Toronto	March 11	1,000,000
Gowganda Premier Silver Mines, Limited	Toronto	January 22	500,000
Gowganda Prince Silver Mines, Limited	Toronto	January 29	1,000,000
Gowganda Prospecting Company, Limited	Ottawa	February 9	10,000
Gowganda Reserve Mines, Limited	Cobalt	July 16	500,000
Great North Company, Limited	Toronto	September 14	40,000
Grey Wolf Mining Company, Limited	Toronto	December 18	100,000
Guelph Oil and Gas Company, Limited	Guelph	September 17	40,000
Hagersville Stone Company, Limited	Hagersville	July 28	40,000
Haileybury Frontier Mining Company, Limited	Haileybury	July 31	1,250,000
Hall Gowganda Mining and Development Company, Ltd.	Toronto	October 1	1,000,000
Hanging Stone Silver Mines, Limited	Toronto	February 15	1,000,000
Harman Mining and Leasing Company, Limited	Cobalt	August 4	500,000
Hassan Mines Development Company, Limited	Ottawa	March 3	500,000
Havilah Gold Mines, Limited	Sault Ste. Marie	January 13	1,000,000
High Falls Mining Company, Limited	Ottawa	September 27	2,500,000
James Bay Company, Limited	Toronto	March 17	100,000
Kaiser Gold Mining Company, Limited	Windsor	May 21	1,000,000
Kirkfield Portland Cement Company, Limited	Toronto	May 10	250,000
Lang-Caswell Cobalt Mines, Limited	Toronto	May 28	1,500,000
LaSalle Mining Company, Limited	Toronto	April 30	100,000
Latour Lake Mines, Limited	Cobalt	October 7	1,000,000
Laurie Silver Mines, Limited	Toronto	January 7	1,000,000
Lavine Lake Silver Mining Company, Limited	Toronto	October 18	300,000
Lemieux Silver Mining Company, Limited	Toronto	January 18	1,000,000
LeRoy Lake Silver Mines, Limited	Toronto	August 23	1,200,000
Logan-Cobalt Silver Mines, Limited	Midland	April 27	500,000
Lorrain, Limited	Hamilton	October 23	1,500,000
Luttrell Gold Separator Company, Limited	Woodstock	January 22	100,000
MacDuff Mining Company, Limited	Milton	February 9	40,000
McDonald Feldspar Company, Limited	Toronto	May 17	40,000
McIntosh Mines, Limited	Toronto	November 10	1,500,000
McLean Temagami Mining Company, Limited	Ottawa	December 7	1,000,000
McNaughton Silver Mine, Limited	Hamilton	October 21	2,000,000
Magna Canadian Silver Mines, Limited	Haileybury	May 17	1,000,000
Mann Mines, Limited	Toronto	March 23	2,500,000
Mapes Johnston Mining Company, Limited	Toronto	August 16	1,000,000
Maple Leaf Portland Cement Company, Limited	Toronto	March 9	150,000
Massada Silver Mines, Limited	Ottawa	December 22	500,000
Merida Mines Company, Limited	Toronto	June 8	500,000
Metagami Mines, Limited	New Liskeard	March 22	500,000
Michigan Cobalt Mines Company, Limited	Windsor	February 2	2,000,000
Miller & Gowganda Mines, Limited	Toronto	March 17	1,500,000
Miller Flatstone Mines, Limited	Toronto	July 27	2,000,000
Millerett Silver Mining Company, Limited	Elk Lake City	July 8	500,000
Mines Holding Company, Limited	Cobalt	May 5	25,000
Montreal-Everett Lake Mining Company, Limited	Toronto	March 26	1,500,000
Montreal-James Mines of Ontario, Limited	Toronto	June 21	40,000
Montreal River "Silver King" Mines, Limited	Toronto	January 13	2,000,000
Montreal-Toronto Syndicate, Limited	Toronto	December 4	250,000
Montrose Cobalt Mining Company, Limited	Toronto	March 17	1,000,000
Morton Silver Mining Company, Limited	Toronto	July 14	700,000
Murilo Gold Mining Company, Limited	Port Arthur	November 30	500,000
Muskoka Sand and Gravel Company, Limited	Toronto	March 22	40,000
National Iron Works, Limited	Toronto	March 15	200,000
Nelson Cobalt Silver Mines, Limited	Cobalt	October 1	750,000
Newfoundland Marble Company, Limited	Toronto	January 6	100,000
North American Silver Mining Company, Limited	Toronto	January 8	2,000,000
North British Mining Company, Limited	Toronto	May 20	1,000,000
North Western Gas Company, Limited	Toronto	June 1	500,000
Northern Provincial Mining Company, Limited	Cobalt	November 17	1,500,000
Oil and Gas Producers, Limited	Hamilton	March 20	1,000,000
Ontario Gowganda-Cobalt Consolidated Company, Limited	Toronto	February 8	40,000
Ontario Sulphur Mines, Limited	Toronto	July 13	1,000,000
Permanent Cobalt Mines, Limited	Toronto	January 5	1,000,000
Pioneer Cobalt Silver Mining Company, Limited	Toronto	January 18	1,500,000
Port Arthur Exploration Company, Limited	Port Arthur	November 5	100,000
Red Willow Coal Company, Limited	Toronto	March 24	1,000,000
Reilly Mining Corporation, Limited	Toronto	March 17	1,000,000
Rib Lake Mining Company, Limited	Toronto	December 20	40,000
Richelieu Silver Mines, Limited	Toronto	November 13	1,500,000
Ridgetown Fuel Supply Company, Limited	Ridgetown	October 28	60,000
Rondeau Gas and Oil Company, Limited	Kingsville	January 19	100,000
Rosey Creek Mines, Limited	Toronto	December 15	75,000
Rubicon Silver Mining Company, Limited	Toronto	March 4	500,000
Ryan (Gowganda) Mining Company, Limited	Toronto	February 22	1,500,000
Sagdola Silver Syndicate, Limited	Toronto	October 16	100,000
Shining Tree Lake Silver Mines, Limited	New Liskeard	November 4	250,000
Silver Country Mines, Limited	Toronto	July 8	1,000,000
Silver Eagle Mining Company, Limited	Toronto	February 3	1,000,000
Silver Falls Mines, Limited	Niagara Falls	July 22	1,000,000
Silver Giant Mining Company, Limited	Haileybury	October 7	2,000,000
Silver Lake Helena Mining Company, Limited	Toronto	June 5	1,000,000
Silver Lake Queen, Limited	Toronto	June 9	600,000
Silver Mines of Canada, Limited	Toronto	November 19	5,000,000

Table XV.—Continued

Name of Company.	Head Office.	Date of Incorporation.	Capital Stock
St. Anthony Prospecting, Developing and Mining Company, Limited	Cobalt	January 28	$500,000
Sturgeon Lake Gold King Mining and Development Company, Limited	Fort William	March 1	200,000
Superior Steel Company, Limited	Toronto	April 15	250,000
Sutherland Cobalt Silver Mines, Limited	Toronto	June 7	1,000,000
Swansea Smelting and Refining Company, Limited	Toronto	November 17	100,000
Tee Arr Mining Company, Limited	Toronto	August 19	1,000,000
Temagami Reserve Mines, Limited	Toronto	January 18	1,000,000
The Actinolite Mining Company, Limited	Belleville	March 4	100,000
The Aldrich Natural Gas and Oil Company, Limited	Selkirk	June 3	40,000
The Beacon Mines, Limited	Cobalt	May 6	40,000
The Black Rock Mines, Limited	London	August 17	2,000,000
The Blakely Oil Company, Limited	Chatham	March 19	25,000
The Blind River Exploration and Mining Company, Limited	Blind River	August 4	25,000
The Blind Trail Silver Mining Company, Limited	Toronto	October 18	40,000
The Boland-Thompson Silver Mining Company, Limited	Ottawa	January 21	1,000,000
The Bonsall Mines, Limited	Ottawa	April 21	3,000,000
The Britannia Silver Mines, Limited	Toronto	September 25	3,000,000
The Buffalo Gowganda Silver Mines, Limited	Toronto	October 26	2,000,000
The Cambrian Mining and Development Company, Ltd.	Port Arthur	August 9	1,000,000
The Canada Northern Explorers, Limited	Sault Ste. Marie	August 31	500,000
The Canada Refining and Smelting Company, Limited	Toronto	November 29	40,000
The Canadian Arsenic Company, Limited	Belleville	October 4	500,000
The Canadian Pressed Brick Company, Limited	Hamilton	December 22	40,000
The Canadian Treadwell Gold Mines Company, Limited	Matheson	October 21	500,000
The Cobalt Commercial Mines, Limited	Toronto	March 23	300,000
The Cobalt Gowganda Consolidated Mining Company, Limited	Toronto	May 15	40,000
The Cobalt Laguna Mining Corporation, Limited	Cobalt	February 9	300,000
The Cobalt Silver Syndicate, Limited	Ottawa	November 2	600,000
The Cobalt Star Mining Company, Limited	Haileybury	October 11	2,000,000
The Cobalt Twins Silver Mining Company, Limited	Cobalt	September 20	2,000,000
The Crown Portland Cement Company, Limited	Wiarton	May 13	800,000
The Delaware-Cobalt Mining anu Exploration Company, Limited	Toronto	July 23	40,000
The Diabase Silver Mines, Limited	Toronto	January 11	1,250,000
The Diamantina Placer Mines, Limited	Toronto	February 12	500,000
The Don Valley Brick Company, Limited	Toronto	January 22	500,000
The Dundas and Wapak Mining Company, Limited	Dundas	February 16	40,000
The Ellis Silver Mining Company, Limited	Toronto	March 19	1,000,000
The Empire Refining Company, Limited	Walkerville	June 16	200,000
The Everett Mines, Limited	Toronto	January 29	1,500 000
The Fedora Cobalt Silver Mining Company, Limited	Cobalt	November 25	1,000,000
The Fonthill Gravel Company, Limited	Thorold	October 21	50,000
The Frontier Consolidated Mining Company, Limited	Haileybury	June 8	1,000,000
The Gargantua Mining Company, Limited	Ottawa	November 4	40,000
The Giroux Lake Cobalt Silver Mining and Milling Company, Limited	Toronto	July 8	1,000,000
The Gladstone Mines, Limited	Toronto	February 11	1,000,000
The Glenorchy Gold Mining and Development Company, Limited	Fort Frances	July 13	500,000
The Gold Pyramid Mining Company of Larder Lake, Limited	Ottawa	March 4	1,000,000
The Golden Rose Mining Company, Limited	Sudbury	April 16	500,000
The Goodwin Lake Cobalt Mines, Limited	Cobalt	January 11	40,000
The Gray Mining Company, Limited	Chesley	November 12	250,000
The Hamilton Fabre Mining Company, Limited	Hamilton	July 20	2,000,000
The Hillcrest Mining Company of Cedar Lake, Limited	Toronto	August 31	1,000,000
The Hudson Bay Mines, Limited	New Liskeard	July 16	3,500,000
The Hudson Valley Cobalt Mines, Limited	Cobalt	January 29	40,000
The Imperial Cement Company, Limited	Owen Sound	May 5	200,000
The International Mining and Information Exchange, Limited	Toronto	May 11	200,000
The International Tool Steel Company, Limited	Toronto	November 13	750,000
The Iron Mask Cobalt Silver Mines Company, Limited	Haileybury	November 19	500,000
The J. C. Mackay Mines, Limited	Toronto	June 15	100,000
The John Black Mining Company, Limited	Toronto	January 28	1,500,000
The Langham Cobalt Mines, Limited	Ottawa	February 15	1,200,000
The Lauzon Lake Company, Limited	Toronto	April 27	500,000
The LeHeup Mining Company, Limited	Toronto	January 29	1,500,000
The Liberty Silver Mines, Limited	Toronto	November 19	750,000
The McRae, Downey Prospecting Company, Limited	Elk Lake	March 31	100,000
The Malouf Mines, Limited	Haileybury	April 20	200,000
The Mascot Mining Company, Limited	Toronto	May 18	500,000
The Mayflower Silver Mining Company, Limited	Haileybury	January 8	150,000
The Merchants Gas Company of Dunnville, Limited	Dunnville	November 30	5,000
The Meteor Silver Mining Company, Limited	Cobalt	November 6	200,000
The Mountain Lake Mining and Developing Company, Limited	Toronto	February 15	500,000
The Nanticoke Natural Gas Company, Limited	Nanticoke	October 12	3,000
The New Ontario Slate Company, Limited	New Liskeard	November 29	500,000
The Northern Mining Company, Limited	Ottawa	August 9	100,000
The Obushkong Mines, Limited	Haileybury	August 17	250,000
The O'Connor Silver Mines, Limited	Cobalt	December 24	500,000

Table XV.—Concluded.

Name of Company.	Head Office.	Date of Incorporation.	Capital Stock.
The O'Kelly Mines, Limited	Toronto	February 15	$5,000,000
The Ontario Consolidated Mines, Limited	Toronto	April 26	350,000
The Ontario Silverfields, Limited	Toronto	June 18	1,000,000
The Ore Chimney Mining Company, Limited	Fort Erie	October 11	600,000
The Ottawa Gowganda Mining Company, Limited	Ottawa	June 17	500,000
The Parry Sound Mica Feldspar Company, Limited	Toronto	March 8	100,000
The Plymouth Silver Mining Company, Limited	Cobalt	June 21	40,000
The Porcupine Lake Gold Mines, Limited	Toronto	December 1	1,000,000
The Prospectors' Exploration and Development Company, Limited	Toronto	August 10	350,000
The Reliance Silver Mines, Limited	Toronto	September 4	1,500,000
The Right of Way Mines, Limited	Ottawa	September 11	2,000,000
The Rosehill Silver Mining Company, Limited	Toronto	May 20	40,000
The Safety Development and Mining Company, Limited	Haileybury	November 3	45,000
The Sarnia Northern Ontario Mining and Development Company, Limited	Sarnia	March 4	750,000
The Saskatchewan Mining and Development Company, Limited	Toronto	November 10	2,000,000
The Saville Prospecting and Exploration Company, Limited	Toronto	January 11	500,000
The Sharon Mines, Limited	Cobalt	May 12	20,000
The Shaw Magnetic Sand Steel Company, Limited	Toronto	May 11	150,000
The Silver Age Mining Company, Limited	Toronto	April 21	1,000,000
The Silver Cliff Mines, Limited	Ottawa	September 15	2,000,000
The Silver Streak Mining Company, Limited	Toronto	April 5	40,000
The Silver-Tunnel Mining Company, Limited	Toronto	March 4	1,500,000
The Silver Wave Mines, Limited	North Bay	October 30	1,000,000
The South Lorrain Silver Mining Company, Limited	Haileybury	February 1	50,000
The St Catharines Exploration and Prospecting Company, Limited	St. Catharines	February 19	40,000
The Stanworth Martin Stone Company, Limited	Port Arthur	March 2	40,000
The Sterling Mines, Limited	Ottawa	September 14	3,000,000
The Susquehanna Mining Company, Limited	Niagara Falls	January 12	30,000
The Tallon Mining Company, Limited	Haileybury	October 1	1,000,000
The Toronto-Buffalo Cobalt Mining Company, Limited	Toronto	November 11	1,000,000
The Union Creek Mining and Milling Company, Limited	Peterboro'	November 29	100,000
The Union Mining and Transport Company, Limited	Toronto	May 6	40,000
The Vermilion River Copper Company, Limited	Sudbury	May 11	50,000
The Victoria Creek Gold Mines, Limited	Toronto	January 18	200,000
The Youngstown Mining Company, Limited	Toronto	September 13	750,000
Thompson Gowganda Mining Company, Limited	Toronto	September 29	500,000
Trafalgar Silver Cobalt Mines, Limited	Toronto	December 18	1,500,000
Tudhope Silver Mines, Limited	Haileybury	September 21	1,000,000
United Fuel Supply Company, Limited	Sarnia	July 6	500,000
United States Silver Mines, Limited	Windsor	January 26	1,000,000
Venture Corporation of Canada, Limited	Toronto	December 29	40,000
Victor Silver Mines, Limited	Toronto	April 13	2,000,000
Wahnapitae Cobalt Silver Mines, Limited	Toronto	October 8	750,000
Waldman Silver Mines, Limited	Toronto	July 20	2,500,000
Wealthy Mines, Limited	North Bay	August 6	1,000,000
Welcome Silver Mines, Limited	Toronto	February 19	40,000
Wellington Mines, Limited	Guelph	December 3	750,000
White Bear Lake Silver Mining Company, Limited	Toronto	August 18	2,000,000
White Reserve Mines, Limited	Toronto	June 14	2,500,000
Wigmore Gold Mines of Sturgeon Lake, Limited	Toronto	May 20	500,000
Willett Silver Mines, Limited	Toronto	May 3	2,000,000
Wyandoh Silver Mines, Limited	Toronto	October 8	3,000,000
			$236,883,000

Table XVI.—Mining Companies Licensed in 1909

Name of Company.	Provincial Head Office.	Date of License.	Capital.
Canada Cement Company, Limited	Toronto	September 30	
East Tilbury (Canada) Oilfields, Limited	Chatham	October 12	$250,000
London Lorrain, Limited	Haileybury	November 30	£5,000
Mud River Silver Mining Company, Limited	Haileybury	March 3	$5,000
Pacific Coal Mines, Limited	Toronto	April 14	
The Canada Iron Corporation, Limited	Toronto	March 26	
The Colonial Development Syndicate	Toronto	Dec. 24, 1908	$40,000
The Jacobs Exploration Company, Limited	Toronto	March 11	
Tranquille Creek Development Company of Canada, Limited	Ottawa	December 16	

In cases where the capital is not given, the company is of Dominion incorporation, and the amount of the capital to be used in Ontario is not mentioned in the license.

The Mining Divisions

Under the Mining Act of Ontario the administration of the mineral domain of the Crown, in so far as the disposition of lands for mining purposes is concerned, is to a large extent in the hands of the Mining Recorders. Each Recorder has jurisdiction over the Mining Division for which he is appointed, his duties being to record applications for mining claims, to settle disputes between contesting applicants, and generally to put the provisions of the Mining Act into effect. There is an appeal from the decision of the Recorder to the Mining Commissioner, who is clothed by the Act with judicial powers in all matters pertaining to mining lands previous to the issue of the patent. From the Mining Commissioner's judgment an appeal may in most cases be taken to the Divisional Court, and thence to the Court of Appeal. It is seldom, however, that a case reaches the Court of Appeal. Most disputes are adjusted by the Recorders, but there is always a considerable number of contestants who demand the adjudication of their rights by the Mining Commissioner. So far the process provided by the Mining Act for the settlement of disputes has worked with much satisfaction, and the Mining Commissioner's skill and experience in this particular branch of the law enable him to decide all cases brought before him with promptitude. The Mining Commissioner, Mr. Samuel Price, barrister, St. Thomas, has now occupied the position for nearly four years. During this time the cases tried by him have involved most of the salient points in the mining law, and a manual dealing with the principles thus established and the cases concerning them would probably be useful for litigants, either actual or prospective, as well as for members of the legal profession interested in mining suits or mining law, and will probably be prepared.

Below is given a list of the Mining Divisions of the Province, with the name and address of the Recorder, and a statement of the receipts of the several offices for the ten months ending 31st October last:—

Table XVII.—List of Mining Divisions, 1909

Mining Division.	Name and P.O. Address of Recorder.	Receipts. Purchase money.	Receipts. Miner's licenses.	Receipts. Recording fees, etc.	Total receipts.
		$	$	$	$
Kenora	W. L. Spry, Kenora	2,096 40	1,404 00	1,872 15	5,372 55
Port Arthur	J. W. Morgan, Port Arthur	885 00	3,906 00	4,582 00	9,373 00
Sault Ste. Marie	S. T. Bowker, Sault Ste. Marie	1,141 66	2,872 00	2,655 00	6,668 66
Sudbury	C. A. Campbell, Sudbury	363 81	5,182 00	10,801 00	16,346 81
Montreal River	Albert Skill, Elk Lake	2,336 52	17,999 00	29,060 15	49,395 67
Gowganda	H. F. Sheppard, Gowganda	319 00	7,876 00	34,387 65	42,582 65
Temiskaming	George T. Smith, Haileybury	10,572 91	16,838 50	12,252 65	39,664 06
Coleman	T. A. McArthur, Cobalt	5,012 82	9,276 00	2,592 75	16,881 57
Larder Lake	J. A. Hough, Larder Lake	1,143 00	1,318 15	2,376 00	4,837 15
Parry Sound	H. F. McQuire, Parry Sound	....	536 00	459 00	995 00
	Total	23,871 12	67,207 65	101,038 35	192,117 12

The remainder of the money received for sale and lease of lands, and for miner's licenses, permits and fees, was taken in at the Department in Toronto.

The Porcupine Division

Following upon the discoveries of gold at Porcupine lake, and in order to provide prospectors with facilities for recording their claims on the spot without having to travel to Haileybury or Sudbury, as the case might be, a new Mining Division, called the Porcupine Division, was established by Order in Council dated 27th January, 1910. Portions of the Temiskaming, Sudbury and Montreal River Mining Divisions were detached to form this Division, the boundaries of which, as set out in the Order in Council, are given below. Mr. Arthur E. D. Bruce, assistant at Haileybury, was appointed Recorder, and the headquarters of the Division were fixed at the townsite of Porcupine, at the east end of Porcupine lake.

The description of the Division is as follows:

(1) That part of the Judicial District of Sudbury described as follows: Commencing at the 138th mile post on the meridian line run by Ontario Land Surveyor Alexander Niven in 1896 and 1898, as the boundary between the Judicial Districts of Nipissing and Sudbury, which point marks the northeast angle of the township of Gowan; thence west astronomically along the north boundary of the townships of Gowan, Wark, Kidd and Macdiarmid to the northwest angle of the latter, a distance of 24 miles more or less; thence continuing due west astronomically along O.L.S. Alexander Niven's base line run in 1905, a distance of 12 miles, to the 18th mile post thereon; thence south astronomically 42 miles; thence east astronomically 36 miles more or less to the 96th mile post on said Alexander Niven's meridian line, forming the boundary beween the Judicial Districts of Nipissing and Sudbury; thence north astronomically along said district boundary 42 miles to the place of beginning, including within said described area the surveyed townships of Gowan, Wark, Kidd, Macdiarmid, Jamieson, Jessop, Murphy, Hoyle, Whitney, Tisdale, Mountjoy and Godfrey, and the unsurveyed townships of Shaw, Fife and Connaught south of the townships of Whitney, Tisdale and Mountjoy respectively, containing by admeasurement 1,512 square miles more or less.

(2) That part of the Judicial District of Nipissing within the hereinafter described limits:

Commencing at the 138th mile post on Ontario Land Surveyor Alexander Niven's meridian line forming the boundary line between the Judicial Districts of Nipissing and Sudbury as run in 1896 and 1898, which point marks the northwest angle of the township of Evelyn; thence east astronomically along the north boundary of said township six miles more or less to the northeast angle thereof; thence south astronomically six miles to the northwest angle of the township of German; thence east astronomically along the north boundary thereof six miles to the northeast angle thereof; thence south astronomically along the east boundary of the said township of German and along the east boundary of the townships of Macklem, Thomas and Blackstock, a distance of 24 miles more or less to the southeast angle of the latter; thence east astronomically along the south boundary of the township of Timmins, 3 miles 45 chains, to the centre of a small pond on the canoe route between the Great Northern Bend on the Montreal river and Night Hawk lake; thence southerly along said canoe route to the north end of Trout lake, and southerly through the centre of Trout lake and along said canoe route to a point in the Great Northern Bend of said Montreal river due east astronomically from the 96th mile post on said district boundary; thence west astronomically to said 96th mile post, a distance of 15 miles more or less; thence north astronomically along said district boundary, a distance of 42 miles to the place of beginning, to include the surveyed townships of Evelyn, Matheson and German, and the unsurveyed townships of Cody, Macklem, Thomas, Carman, Langmuir and Blackstock, containing by admeasurement 520 square miles more or less, said two parcels containing 2,032 square miles.

Brief reports from the several Mining Recorders, dealing with the business transacted in their offices for the year ending 31st December, 1909, are herewith appended:—

Kenora

Recorder, W. L. Spry, Kenora, who succeeded C. W. Belyea, 21st September, 1909.

Miner's licenses issued, 196; renewals, 75; mining claims recorded, 102.

Port Arthur

Recorder, J. W. Morgan, Port Arthur.

Miner's licenses issued, 647; renewals, 274; mining claims recorded, 475.

Twenty-five claims were recorded for placer gold on Savant lake, but owing to difficulty in access very little can be done on these claims until spring. Silver has been discovered on Black Bay peninsula, and gold north of Lynx lake. These are in new territory, and no doubt there will be extensive prospecting in both localities when the snow leaves the ground.

The work of the office has more than doubled as compared with 1908.

Sault Ste. Marie

Recorder, S. T. Bowker, Sault Ste. Marie.

Miner's licenses issued, 344; renewals, 157.

Sudbury

Recorder, C. A. Campbell, Sudbury, who succeeded F. F. Lemieux, deceased. Mr. Campbell was appointed 6th January, 1910.

Miner's licenses issued, 823; renewals, 298; mining claims recorded, 1,859.

Gold was reported from Secord township as existing in large bodies of granite or conglomerate containing quartz, and carrying from $2 to $7 per ton. Iron claims were recorded (in 1910) on P. L. S. Sinclair's exploration line of 1867 about five miles east of Peter Long's lake. Staking for silver was active at Rosie creek and Esker lake. Many claims were recorded for gold in the vicinity of Tisdale and Mountjoy townships prior to this territory being included in the new Porcupine Mining Division.

Montreal River

Mining Recorder, Albert Skill, Elk Lake.

Miner's licenses issued, 1,540; renewals, 1,039; mining claims recorded, 2,573; certificates of record granted, 508; ditto work, 251.

The year 1909 has been the most active one in the history of the Division. Notwithstanding the loss of the territory added to the Gowganda Division, the receipts more than doubled those of 1908. About 500 claims have been staked in the township of Shillington and in the unsurveyed territory lying to the north. Considerable work has been performed in the Maple Mountain district, and several rich discoveries of silver are reported from that neighborhood.

Gowganda

Mining Recorder, H. E. Sheppard, Gowganda.

Miner's licenses issued, 995; renewals, 283; certificates of record granted, 934; ditto work, 210; mining claims recorded, 3,064.

There is considerable activity in mining operations in the vicinity of what is known as the Mann Ridge on the west side of Gowganda lake, also at Miller lake, Calcite lake and Bloom lake.

New discoveries of silver are reported from Smoothwater and Shining Tree lakes, also on Rosie creek and near Phoenix.

Approximately the following proportions of the townships mentioned have been staked out: Milner, seven-eighths; Van Hise, Haultain, Nicol, Leith, three-quarters each; Tyrrell, nine-sixteenths; Leonard, five-eighths; Morel, one-half; Brewster, one-third; Rankin, Raymond, Charters, N. Williams, Ray, Donovan, Dufferin, one-fourth each; Knight, one-sixth; Leckie, Corley, Gamble, Corkill, one-ninth each; Gamble, one-thirty-sixth.

Temiskaming

Mining Recorder, George T. Smith, Haileybury.

From the 1st of January to 31st October, 1909, 1,399 miner's licenses were issued, 1,565 miner's licenses were renewed, and 1,343 applications for mining claims recorded. From 1st of November to 31st December, 1909, 398 miner's licenses were issued, and 1,038 applications for mining claims recorded, making in all for the twelve months ending 31st December, 1909, 1,737 miner's licenses issued, 1,565 renewal licenses issued, 2,381 applications for mining claims recorded.

While the year 1909 was a fairly active one throughout the Province, the Porcupine lake gold discoveries formed the sensational feature. The first claim in this section was recorded on 20th December, 1906, when Mr. E. O. Taylor, of Toronto, located what is known as "E.B. 12," in the township of Shaw, on a discovery of iron showing traces of gold. A number of claims were recorded in the month of July, 1907, on lots 10 and 11 in the 1st Concession of the township of Whitney, the first of which was filed on 9th July by

Mr. Ernest R. Ostrom, of Haileybury, on behalf of Mr. Wm. J. Kernahan, of Toronto, on a discovery of gold-bearing quartz. Additional claims were recorded in the early part of 1908, both in these townships and in the vicinity of Night Hawk lake, but nearly all were forfeited for want of performance of development work.

Mr. John S. Wilson, of Massey, Ont., appears to have been the first applicant in 1909 in the Porcupine lake gold fields, having filed his first application on 22nd June, 1909, for the N.E. $^1/_4$, S. ½ Lot 2, Con. 2, Whitney, which is one of the claims that afterwards became famous as the "Wilson-Edwards gold claims".

The Way-Bannerman, Tremblay-Frood and Hollinger-McMahon claims were located in July and August, after which the staking became general, the reported discoveries extending from the townships of Shaw, Mountjoy, Godfrey, Tisdale, Jamieson and Whitney to the Temagami Reserve,

The country in the vicinity of South Lorrain had a very active and satisfactory season, and considerable development work has been done in the townships of Munro, Guibord, Clergue and Dundonald. A number of claims were also recorded in the unsurveyed district west of the township of Holmes, adjacent to Canoe lake. A good deal of development work was also done in the townships of Lorrain and Bucke, although no ore was shipped from either of these townships.

Reports come in from time to time of valuable discoveries along the line of the Transcontinental railway, but so far nothing of any great importance appears to have materialized.

Coleman

Mining Recorder, T. A. McArthur, Cobalt.

Miner's licenses issued, 998; renewals, 800; mining claims recorded, 150.

Larder Lake

Mining Recorder, J. A. Hough, Larder Lake.

Miner's licenses issued, 64; renewals, 134; mining claims recorded, 180.

New finds of gold were made during the year in the townships of Gauthier and Skead, and some excellent samples brought out from both localities.

Parry Sound

Mining Recorder, H. F. McQuire, Parry Sound.

Miner's licenses issued, 69; renewals, 51.

There have been no new discoveries. In the township of Lount there is some activity, certain American capitalists having a considerable tract under option and being now engaged in testing the same for iron and copper.

Government Diamond Drills

Drill "C" was not in commission during the year.

Drill "S," under the management of Mr. J. A. McVicar, was operated near Cobalt on the property of the Silver Bar Mining Company, Limited. In all four holes were drilled. Work was started February 6th, 1909, and finished July 23rd, 1909. The total depth drilled was 1,192 feet, and the average daily footage was nearly 9.7 feet. The gross cost of the work was $6,836.21, or $5.73 per foot. The net cost, after deducting 35 per cent. borne by the Department, was $4,443.56, or $3.78 per foot. Two shifts were run during each 24 hours.

No. 1 Hole.—Direction due north, angle 63½ degrees, reached a depth of 425 feet and pierced the following formations: Conglomerate, 50 feet; cobalt ore, 2 inches; Keewatin, 361 feet; calcite, 2 inches; Keewatin, 13 feet 8 inches.

No. 2 Hole.—At a depth of 50 feet in the diabase this hole was abandoned owing to the broken nature of the ground and its tendency to cave on the bits. The angle was 15 degrees.

No. 3 Hole.—Direction N. 10 degrees, E. angle 20 degrees, depth 294 feet. The log given by Mr. McVicar is as follows: boulder clay, 13 feet; diabase, 17 feet; Keewatin, 85 feet; cobalt ore, $\frac{1}{2}$ inch; Keewatin, 14 feet $7\frac{1}{2}$ inches; cobalt ore, $1\frac{1}{2}$ inches; Keewatin, 164 feet $2\frac{1}{2}$ inches.

No. 4 Hole.—Direction S. 70 degrees E., angle 20 degrees, depth 360 feet. The core showed: boulder clay, 18 feet; remainder, Keewatin.

As already stated, both plants have been sold, and the Department has discontinued the practice of supplying drills for prospecting purposes.

Provincial Assay Office

Mr. N. L. Turner, Provincial Assayer, reports as follows:—

The Provincial Assay Office was established in July, 1898, by the Ontario Government as an aid to the mineral development of the Province. During the twelve years of its existence it has been of great service not only to the Bureau of Mines, but also to the general public. The fees charged have been kept as low as possible, in order that all may be able to send their samples in for examination and report. This price list is maintained without regard to charges levied by other offices and is from 25 to 50 per cent. lower than that of private assayers. No attempt, however, is made to advertise the office or in any way compete with others engaged in this line of work. The office is equipped with all the necessary apparatus for the examination of the various ores of the Province.

During the past year no particular part of the Province can be said to have supplied the bulk of the samples, specimens having been received from all parts of the Province and also from Quebec, New Brunswick, Nova Scotia, Newfoundland, Manitoba, British Columbia, and various parts of the United States. It will be seen that the office is pretty well known and that it has built up a reputation for accurate work at a low cost.

Many fine samples of hematite and magnetite were received from the northern part of the county of Hastings and adjoining townships.

As usual, numerous samples of cobalt-silver ore were received from Cobalt and the adjoining districts, also nickel-bearing pyrrhotite from Sudbury. Samples of gold ore were received from the Kenora district, as well as some very fine samples of copper ore.

During the latter part of the year a sample of very good coal was sent in, said to have been found in New Ontario, but so far no further information has been obtainable regarding it.

From other parts of the Province were received samples of gold and silver ore, copper, lead, zinc, and also non-mettalic minerals such as limestone for cement purposes, feldspar, corundum, mica, etc.

During the year there have been numerous inquiries for good deposits of mica and fluorite, and a ready market could be found for these minerals, particularly the latter.

Work for Bureau of Mines

1. Checking the sampling of cobalt-silver ores shipped from the O'Brien, Crown Reserve and Hudson Bay Mines to the smelters at Copper Cliff, Deloro and Thorold.
2. Assaying the check samples and totalling the silver values of the cars of ore.
3. Analysis of iron ore samples for the report on the iron ores of Ontario.
4. Analysis of rock specimens from various parts of the Province.
5. Identification and analysis of samples submitted by the officials of the Bureau.

Work for the Public

1. Issuing reports, consisting of assays, analyses, and identification of samples submitted for examination.

2. Supplying information to owners, buyers and others connected with the mineral development of the Province.

3. Special testing of minerals to ascertain the best method for the extraction of their values.

The number of samples submitted for examination during the year was 1,063. Fees to the amount of $738.75 were collected and transmitted to the Department, and work was performed for the Bureau of Mines to the value of $1,320.50, making a total value of the work done $2,059.25.

Assays and Analyses Made

The following list of determinations will show the laboratory work for the year:—

	Assays for Public.	Assays for Bureau.	Total.
Gold	317	38	355
Silver	281	266	547
Copper	49	....	49
Cobalt	22	110	132
Nickel	7	5	12
Manganese	2	....	2
Molybdenum	2	....	2
Zinc	8	....	8
Lead	11	....	11
Platinum	4	....	4
Arsenic	20	12	32
Tin	3	....	3
Bismuth	2	....	2
Chromium	...	1	1
Vanadium	2	....	2
Antimony	2	....	2
Concentration gold tests	1	....	1
Amalgamation gold tests	4	2	6
Total	737	434	1,171

	Analyses for Public.	Analyses for Bureau.	Total.
Metallic iron	55	105	160
Ferric oxide	6	....	6
Ferrous oxide	....	3	3
Alumina	26	....	26
Silica	7	8	15
Lime	6	20	26
Magnesia	8	20	28
Potassium	2	....	2
Sodium	2	....	2
Sulphur	30	80	110
Phosphorus	24	54	78
Titanium	22	5	27
Carbon	5	....	5
Ash	1	1	2
Carbon dioxide	...	21	21
Loss on ignition	4	....	4
Moisture	3	....	3
Chlorine	....	1	1
Tungsten	1	....	1
Barium oxide	2	...	2
Insoluble	2	79	81
Complete qualitative analyses	3	....	3
Complete rock analyses	....	18	18
Miscellaneous	....	1	1
Total	209	416	625
Assays	1,171		
Analyses	625		
Identifications	103		
Total	1,899		

Methods of Analysis

The standard methods of analysis are used:—

Gold and silver by pot assay, using one half assay ton samples, and each sample being run in duplicate, thus eliminating any chance of error.

Silver in silver-cobalt ores:—A combination wet and dry method is used for this assay. For ore 2,000 ounces per ton and over, one-tenth assay ton is taken; for anything under that one-fifth is used. The sample is leached out with nitric acid, and the silver precipitated with hydrochloric acid. The solution is filtered and the residue washed with hot water and then dried on a scorifier. The paper is burned off carefully, and the remainder scorified in the usual manner.

For other assays standard methods are used, although the office adopts any newer and later methods, when proved, in order to keep up to date.

Notes

In sending in samples it is desirable to have them no more than three pounds in weight. All samples are sampled down and ground to 100-mesh, and where necessary, finer. Wet samples are dried at 107 degrees C., and analyses reported at that temperature.

Circulars giving list of fees and other particulars will be sent to anyone interested and also sample bags to send samples in. To insure a prompt report all fees must accompany samples.

Samples brought to the office will be examined free of charge. The following list will give the charges for the ordinary assays:—

Price List for Assays

	1 Sample.	3 to 5 Samples at one time, each.	6 or more Samples at one time, each.
	$ c.	$ c.	$ c.
Gold by fire method	1 00	0 90	0 75
Silver " "	1 00	0 90	0 75
Gold and silver by fire method	1 25	1 00	0 90
Gold by amalgamation assay for free gold	2 00	1 80	1 50
Copper by fire assay method	1 25	1 00	0 90
Copper by cyanide method	1 25	1 00	0 90
Copper by electrolytic method	1 25	1 00	0 90
Lead by titration method	1 25	1 00	0 90
Zinc " "	2 00	1 80	1 50
Nickel by electrolytic method	3 00	2 70	2 25
Platinum by fire assay "	2 00	1 80	1 50
Cobalt by electrolytic "	3 00	2 70	2 25
Arsenic by titration "	2 00	1 80	1 50
Manganese " "	3 00	2 70	2 25
Chromium " "	3 00	2 70	2 25
Antimony " "	2 00	1 80	1 50
Bismuth " "	2 00	1 80	1 50
Iron (metallic) " "	0 50	0 45	0 30
Molybdenum " "	2 00	1 80	1 50
Tin fire assay " "	2 00	1 80	1 55

A reduction of 15 per cent. on the total is allowed on 6 or more assays on one sample, and 20 per cent. on 10 or more assays on one sample.

MINING ACCIDENTS

By E. T. Corkill, Inspector of Mines

During the year 1909, at the mines regulated by the Mining Act of Ontario, there were 45 fatal accidents, causing the loss of 49 lives, being an increase of 2 over the previous year. Of the fatalities, 36 occurred below ground and 13 above ground. The total number of serious accidents in the mines of Ontario reported to the Bureau of Mines was 77, resulting in 49 men killed and 53 injured. Of the accidents reported 61 occurred below ground, and 16 above ground. The fatal accidents took place at mines operated by 30 different companies.

Analysis of Fatal Accidents

From an analysis of the fatalities in Ontario in 1909, it is found that 34.7 per cent. resulted from accidents due to danger inherent to the work itself; 10.2 per cent. from accidents arising out of defects in the mine workings; 8.2 per cent. from accidents through fault of fellow workmen; 40.8 per cent. due to accidents through fault of injured person, and 6.1 per cent. impossible to classify. This is an improvement in one respect over 1908. In that year 31.9 per cent. resulted from defects in the mine workings, while 1909 shows only 10.2 per cent. The marked increase is in the number of fatalities caused through the fault of the injured person. This increased from 14.9 per cent. in 1908 to 40.8 per cent. in 1909.

The 45 fatal accidents took place in the following months:—January, 3; February, 2; March, 6; April, 5; May, 3; June, 3; July, 4; August, 2; September, 5; October, 3; November, 1; December, 8.

An investigation and report were made in 38 out of the 45 fatal accidents that occurred during the year, besides a number of non-fatal accidents.

The following shows the number of men killed at the different classes of work:—

Machine men	17
Surface laborers	9
Machine helpers	8
Hand miners	5
Muckers	4
Timberman	1
Cage tender	1
Pipe fitter	1
Teamster	1
Crusherman	1
Brakeman	1
Total	49

In 1908 there were 47 men killed in Ontario, 39 below ground and 8 above ground. Of these deaths, 11 were due to falls of ground, or 23.4 per cent.; 13 to shaft accidents, or 27.6 per cent.; 11 were caused by explosives, or 23.4 per cent.; 4 by miscellaneous causes underground, or 8.5 per cent.; and 8, or 17.8 per cent., were due to casualties on the surface.

Of the 49 fatalities in 1909, 10.2 per cent. resulted from falls of ground; 20.4 per cent. from shaft accidents; 34.7 per cent. from explosives; 8.1 per cent. from miscellaneous causes underground, and 26.6 per cent. from accidents on the surface.

In comparing the two years, we find there was a marked decrease in fatalities from falls of ground, which were reduced from 11 in 1908 to 5 in 1909; there were also fewer shaft accidents. The fatalities from explosives were higher, being 17 in 1909, as against 11 in 1908. The number of miscellaneous accidents underground was the same, but there were more accidents on the surface, the number being 13 in 1909, compared with 8 in 1908. There were 36 fatalities underground in 1909, or 3 less than in 1908.

Cause and Location of Fatalities

The following schedule shows the cause and place of the fatal accidents in 1909:—

Falls of ground		5
Shaft Accidents:		
Falling from bucket while riding contrary to Act	1	
Falling from bucket	1	
Falling from bucket while overcome by gas	1	
Falling into shaft	1	
Objects falling from bucket	1	
Cage accidents	5	
		10
Accidents from Explosives:		
Premature explosion while loading or lighting hole	7	
Picking or putting bar into old hole in which explosive had been left	1	
Drilling into bottom of old hole	4	
Picking into explosive in muck	3	
Explosion while scaling	2	
		17
Miscellaneous Accidents Underground:		
Falling through timbers into stope	1	
Suffocation from gases resulting from blasts	2	
Piece of timber falling off cage	1	
		4
Accidents on Surface:		
Caught by elevator	1	
Struck or run down by train	2	
Explosion in rock house	1	
Thawing dynamite	1	
Walking over place where blast had been lighted	1	
Explosion of settler	2	
Blasting hot salamander in furnace	1	
Miscellaneous	4	
		13
Total		49

The following table gives the number of men killed in Ontario from 1900 to 1909; the number of persons employed in producing mines; the estimated number of persons employed in non-producing mines, and the death rate per 1,000 men employed. As shown by this table, the accident rate has been increasing from 1904 to 1908, that of 1909 being about the same as 1908. The increase is due to the expansion and activity of the mining industry in Ontario since the discovery of the high grade silver ores at Cobalt. Accidents from explosives are the main source of danger, and were ultimately the cause of 49 per cent. of the fatalities in 1909. The necessity for an inspection of explosives, which can only be instituted by the Dominion Government, is clearly proved by the death rate due to their use, not only in Ontario but throughout Canada:

Table showing Fatal Accidents in Mines of Ontario, 1900 to 1909

	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	Total.
Persons killed in producing and non-producing mines	17	13	10	7	7	9	11	22	47	49	192
Persons employed in producing mines	3,330	4,135	4,426	3,499	3,475	4,415	5,017	6,305	7,435	8,505	50,442
Persons employed in non-producing mines (estimated)	650	550	450	400	400	500	750	1,140	1,750	2,000	8,590
Total persons employed	3,980	4,685	4,876	3,899	3,875	4,915	5,767	7,345	9,185	10,505	59,032
Fatal accidents per 1,000 employed	4.27	2.77	2.05	1.79	1.80	1.83	1.90	2.99	5.11	4.66	3.25

The various fatal accidents are briefly described further on in this report, but the following remarks are given in elucidation of the several causes.

Falls of Ground

There were 4 accidents from this cause, resulting in the death of 5 men. Three of the fatalities took place in iron mines, namely, the Helen and Mayo, and two in the Crean Hill copper-nickel mine. The deaths from this cause in 1908 were 11, which shows a marked improvement in 1909.

The change in the Mining Act compelling the companies to keep scaling books, in which is entered the record of scaling done in the mine signed by the men doing it, has proved beneficial. Workmen are naturally careless, but if they know that after scaling the roof and walls they must sign a statement that they have left them in safe

condition, they are likely to be more careful in their work. The mines of Ontario, as a rule, have safer ground to work in than those of many other countries. Presuming on this, men sometimes get careless and work under ground that should be scaled.

At the Helen mine an accident occurred resulting in two men being crushed under about 50 tons of ore. This accident was caused by the ore falling away from a soft slip that cut across one wall of the stope. A long machine hole had been drilled under this and the ground had not been properly examined after the blast before the men returned to work.

Shaft Accidents

Although only ten men lost their lives from accidents of this sort in 1909, compared with 13 in 1908, it is not reassuring when we consider that 5 of these fatalities were the result of cage accidents. All of these accidents were the result of carelessness on the part of someone. Getting on or off moving cages was responsible for two of the deaths. This is a very dangerous practice, and anyone guilty of it should be dismissed. One cage tender was killed through someone, unknown, ringing the hoisting signal while he was putting the car on the cage. The cage started, causing him to fall down the shaft.

Bucket accidents have shown a decided decrease. Two workmen were prosecuted and convicted for violation of the law regarding bucket riding. There were no accidents during the year from falling crossheads. This improvement may be accounted for in part by the companies being compelled by law to have the crosshead so constructed that it cannot stick in the shaft without also stopping the bucket.

Accidents from Explosives

The fact that 17 men lost their lives through explosive accidents underground in 1909 is also discouraging. This is a cause of accident that is exceedingly difficult to guard against. There were last year in all 24 fatalities caused by explosion or from gases, or 49 per cent. of the total fatalities. There is no country that publishes accurate statistics where the accidents from explosives constitute so large a percentage of the total number. It is not easy to account for this. There is no doubt that the extremes of heat and cold make the handling of explosives more dangerous. There is also a probability that some of the explosives used by the mines are not uniform in composition.

So-called "premature" explosions, which are generally classed as quick fuse, are very prevalent, having resulted in 7 fatalities in 1909. These accidents are generally caused by the fuse spitting into the powder in one of the holes in which no tamping has been placed. The necessity for putting tamping on powder in the holes, outside of the economic importance, has been shown in several cases of accident. No miner should be allowed to light a round of holes unless he has tamping in every one. Two men were killed in 1909 while loading holes. The only cause that could be found for these two accidents was that in pushing the powder into the hole too much force was exerted, causing the gelignite to explode. The old, careless practice of starting to drill in the bottom of old holes was again responsible for 4 deaths. The Mining Act makes this practice illegal, but where a fatality follows, the man responsible for it is generally the one who is killed. Contractors are very often guilty of this breach of the Act.

Miscellaneous Accidents Underground

Two persons lost their lives through being asphyxiated with gases emanating from the explosion of dynamite. The men were exposed to the gases from fifteen to twenty minutes only, but, although they lived for a few hours after being brought out of the mine, the doctors were unable to resuscitate them. At one of the inquests the physician gave evidence that he considered the death was caused by carbon-monoxide poisoning. This would indicate a lack of oxydizing agent in the dynamite, causing an incomplete combustion.

Accidents on Surface

There were 13 fatalities on the surface in 1909, compared with 8 in 1908, an increase of 5. Four resulted from explosion of powder, 2 from explosion of settler in smelter, 2 from being run down by train, and the others were due to miscellaneous causes.

These accidents are all described in another part of this report, but two of the accidents require additional comment. One of the fatalities was the result of thawing dynamite in a can over an open fire. The dynamite naturally exploded, killing one man and injuring another, although not seriously. This accident occurred at a prospect, and one of the men injured was in charge of the work. As long as foolhardy methods of thawing explosives such as mentioned above are used, we may expect to have accidents. Explosives are treacherous in their behaviour, and consequently need to be handled very carefully.

Another accident occurred in blasting out the salamander in the bottom of a blast furnace. The salamander was so hot that it caused the powder to smoke when placed on it. An iron pipe was used to put the dynamite in, as a protection. However, the charge exploded prematurely, killing one man. The Mining Act at the time of the accident prohibited the use of explosives in hot or heated ore. This provision did not apply in the above case, and an amendment was passed at the last session of the Legislature which makes the law to read as follows: "No powder, dynamite or other explosive shall be used to blast or break up ore, salamander or other material, where by reason of the heated condition of the ore, salamander or other material there is any danger or risk of premature explosion of the charge."

General Health of Miners

During the late summer and the fall of 1909 a bad epidemic of typhoid fever broke out in Cobalt and spread to the mines in the vicinity of the town. The Red Cross hospital, which is the hospital for the mines, was taxed to its utmost, necessitating a large staff of nurses and the use of hospital tents, but handled the large number of patients in an excellent manner. There was also much typhoid in the other silver-mining camps, and indeed in northern Ontario generally. The contamination of the drinking water was the chief source of the disease. It is necessary that pure drinking water should be supplied the men underground as well as on the surface. The use of portable privies in such shallow workings as those at Cobalt has some points of advantage, but more of disadvantage. Supplying pure drinking water and strictly enforcing the rule against contamination of the underground workings are the best safeguards for the health of the workmen.

Mines Hospital at Cobalt

The Red Cross hospital at Cobalt, to which nearly all the mines subscribed during 1909, has been taken over by a company known as The Cobalt Mines Hospital, Limited. Each of the mining companies is expected to subscribe for a number of shares of stock *pro rata* with the number of men it employs. The latter are then assessed 50 cents per man per month for the support of the hospital, for which they receive full hospital privileges in case of injury or illness. No profit is to be made by the hospital company, and any surplus is to be devoted to improvements or reduction of fees. During the epidemic of last year a large debt was incurred, which had to be met by the mining companies. At the height of the epidemic more than 200 patients were being cared for by the hospital, besides looking after a number of patients throughout the town.

The fatal accidents that occurred during the year are described in detail, after which is given a table of fatal and non-fatal accidents.

Algoma Steel Company

At the blast furnace of the Algoma Steel Company, Sault Ste. Marie, on October 6th, 1909, Henry Foster was killed by an explosion of dynamite while blasting hot salamander. The furnace had been blown out and, after it had become sufficiently cool for

men to work in it, the loose material, consisting chiefly of slag, was removed by pick and shovel. When the salamander was reached it was found too hot to be handled by this means. Accordingly an explosive was used to break it up. Work by drill and blasting had been in progress for about three days. Very little headway was made by hand, on account of the hardness of the material. The deceased had been employed by the company for about four years. During that time he had been engaged in various kinds of work, but never in handling explosives. Prior to the accident he had been employed on the scale car. The foreman, Mr. D. Rinker, had instructed Foster when blasting in the hot salamander to take an inch-and-one-quarter iron pipe about 18 inches to 2 feet in length, and put the explosive in it to protect it from the heat of the material. The hole that exploded prematurely was loaded in this manner. Kenneth Keith was in the furnace with Foster while the hole was being loaded, and stated that before Foster had completed the loading of the hole the dynamite began to smoke and water was thrown on it to keep it from catching fire. Keith took alarm and climbed out of the furnace. He had just got out when the explosion occurred. Immediately after the explosion Foster was seen to climb out of the furnace and was helped by Keith. Blood was pouring from a wound in his neck. He expired a few minutes afterwards, death being due to a severing of the jugular vein.

The coroner's jury returned the following verdict: "Henry Foster came to his death through an accident caused by a premature explosion of dynamite, the cause of the explosion being unknown to us."

Badger Silver Mine

At the Badger silver mine on June 22nd, 1909, Henry Davis, teamster, was killed by being caught between the cage and the shaft timber. Davis was waiting at the shaft house for a load of rock, when he volunteered to help the deck man fasten the hood. The cage was resting on the chairs at the surface and Davis climbed up on the timber, in order to bolt the hood together. It was found that, owing to the cage resting altogether on the chairs, the hood was jammed on the bar so that it could not be fastened. The cage tender had, accordingly, to signal the engineer to raise the cage. He first asked the deceased if he was clear of it, and he replied by saying he had lots of room. The cage was hoisted, but the engineer stopped it when he felt something catching. The deck hand saw that Davis had been caught between the cage and the timber and rang the cage down, when Davis fell to the floor quite dead.

The coroner's jury brought in the following verdict: "That Henry Davis was accidentally killed at the Badger mine on June 22nd, 1909, by being jammed between the cage and timber in the shaft house."

Big Six Silver Mine

At the Big Six silver mine, owned by the Big Six Mines, Limited, on October 5th, 1909, D. H. McGillivray, machine runner, was caught by an explosion while lighting a round of holes in the shaft.

Two machines were working in the shaft. A round had been drilled and McGillivray and another machine man stayed in the shaft to light a round of holes, each having three holes to light. The evidence of McGillivray's helper showed that he had not put tamping in any of the holes. Just as both men finished lighting the holes they stepped on the bucket and rang the signal to hoist. About the same time the powder in one of the holes that McGillivray had loaded began to burn and, when the bucket was about 15 feet from the bottom, there was an explosion and McGillivray was knocked off the bucket, the other man being hoisted safely to the surface. There was no time to go down the shaft after McGillivray before the rest of the holes exploded. He was found, when they were able to get into the shaft, partially buried in the loose rock and quite dead.

The explosion was caused by McGillivray failing to put any tamping on the powder in the hole, which was ignited by one of the fuses spitting into the hole after it was lighted.

Bruce Mines

At the Bruce Mines on July 22nd, 1909, Gus Matilla, timberman, was killed by being caught between the cage and the timber. Matilla had been employed at the Bruce Mines for only a few days as timberman. On the day of the accident he was working on the fourth level cutting hitches for stulls. About 4.30 p.m. he came to the station with some moils, which he put on the cage, and got on himself to go to the surface. J. Lapham rang up the cage. After the cage had got about half way between the third and fourth levels the men on the fourth level heard a shout from the deceased, calling to stop the cage. They at once rang one bell, the signal to stop. Almost immediately they saw the deceased fall down the shaft into the sump. He was picked up and taken to the surface, but was dead before he arrived there. It was found that his back was broken and his spinal cord severed.

Canadian Copper Company

Crean Hill Mine

At the Crean Hill mine on January 19th, 1909, Edward Salmet, machine runner, was killed through inserting an iron blow-pipe into a missed hole, causing an explosion.

From the evidence it appears that the deceased had found a drill hole near the place where he was drilling. In order to take advantage of this hole he had taken an iron blow-pipe and commenced to blow out the hole. Some of the men near him warned him not to do so. He persisted, and an explosion resulted, causing his death.

The coroner's jury returned the following verdict: "That Edward Salmet came to his death on January 19th about 11.40 p.m., on the fifth level of the Crean Hill mine, through carelessness on his own part in blowing out a missed hole."

At Crean Hill, on April 15th, Kalli Jarvis, machine helper, was killed by being struck on the head with a piece of falling rock while working on No. 1 stope of the third level.

On the above date, Kalli Jarvis and Aksil Jansen, machine runner, were set to work in the stope. This was the first shift they had worked here, as they had been scaling down the side of the stope until about 9.30 a.m. They set up the machine and began drilling. At about 11.45 a.m. Jansen was struck on the head by a piece of falling rock and knocked off the machine. He could not find his partner and went up to tell the shift boss. They returned together, and found Jarvis lying on his face about 6 feet from the machine, quite dead.

The evidence of the men and of Mr. H. C. Meek, mine superintendent, showed that 3½ shifts had been spent, on the 29th, 30th and 31st March, scaling this particular part of the stope, and that two men had been employed five hours on Saturday, April 10th, scaling the foot wall of this stope, but no scaling had been done since March 31st on the roof or the wall of the stope under which Jarvis and Jansen were working.

The coroner's jury returned the following verdict: "We find that the deceased came to his death by being struck on the head by a piece of falling ground while at work at the Crean Hill mine on April 15th."

At the same mine on June 22nd, 1909, Mike Bekic, trammer, was struck on the head by a piece of falling rock while working in the first level of the mine.

The wall, near which the deceased was working, had been scaled that morning, but shortly after a large mass of ore fell from a height of about 20 feet. A small piece of the flying rock struck Bekic on the head, from which injuries he died a couple of hours later.

An inquest was held and a verdict of accidental death returned.

Koski Johnson and Dominic Dalc were killed at the Crean Hill mine by an explosion on December 15th, 1909. The accident occurred on the second level of the mine, which is now being worked as an open stope, part of the floor of the first level having been broken down. Koski Johnson was a machine helper, but on the day of the accident, his partner being ill, he was put on to run the drill. Dominic Dalc was engaged in running a hammer drill about 20 feet from the place where the accident occurred. About 12 o'clock, Fred Luff, shift boss, blasted one hole which was 10 feet in length, using 10 sticks of No. 1 gelignite. He went back after the blast to examine the ground and found some rather loose. He put 6 sticks of gelignite behind the loose piece and blasted it. On coming on shift at 1 o'clock Johnson began to scale down the side of the pillar where the blasting had been done. He had scaled down the lower part with a short bar, and saw some loose ground higher up the side of the pillar. He took a long blow-pipe and pried down a piece about 200 pounds in weight. An explosion instantly followed, killing Johnson and Dalc and injuring James Capporici slightly about the face. The explosion must have been caused by the piece of rock which fell striking some gelignite.

The coroner's jury brought in a verdict of accidental death.

Creighton Mine

At the Creighton mine, owned by the Canadian Copper Company, on November 4th, 1909, Adanti Anabel, crusher man, was killed by an explosion of dynamite in the rock house.

About five minutes before the accident the powerman had prepared and delivered to the machine runner at the surface 180 sticks of dynamite, being in two bags, one containing 100 and the other 80 sticks. These bags were put in the skip by the machine man, a tag containing the word "dynamite" being attached to the bale of the skip, to show the skip tender on the third level that there was powder in it. When the skip arrived at the third level the skip tender got into the skip, took out the bag containing 100 sticks and then got out of the skip. At this time the shift boss, J. Caesar, came to the station and asked him if that was all the powder there was in the skip. The skip tender stated that it was, and took another look to make sure. A car of ore was then dumped in the skip and sent up. This was dumped automatically over the grizzly in the rock house into the crusher. An explosion immediately followed, killing Anabel and blowing the top off the rock house.

The coroner's jury returned the following verdict: "That Adanti Anabel came to his death through the explosion of a quantity of dynamite which exploded in the Creighton mine rock house, due to an oversight on the part of the skip tender in not removing the dynamite from the skip."

Smelting Works

On September 18th, at the smelter yards of the Canadian Copper Company, Mariphetto Giovanni was killed, by falling in front of a moving train.

The man had been employed for several months to clean up round the slag tracks at the rear of the smelter. The smelter locomotive was pushing a car over one of the tracks where Giovanni was working. He was seen to step in front of the car and, although warned by the trackmen, was struck down, the car passing over him.

The coroner's jury brought in the following verdict: "That Giovanni came to his death on September 18th, 1909, in the Canadian Copper Company's smelter yards, and the death was accidentally caused by the deceased's own carelessness."

At the ash dump near the smelter of the Canadian Copper Company on December 20th, 1909, John Slako, labourer, was found burnt to death. The deceased had gone to work on Sunday at noon and, with the rest of the shift, should have worked until the following morning at 7 o'clock, the change of shift making it necessary that each week one shift should work 18 hours. At about 3 o'clock in the afternoon the yard foreman put him at work cleaning out the ash pit. This is a short distance from the turn-table, and is

where the locomotives clear their fires at night before going into the round-house. The pit is cleaned out each day, the ashes being removed by the yard man to a dump probably 100 feet away. Slako was working alone, and was last seen about 6 o'clock on Sunday evening, when he was eating his supper near the slag elevator. The foreman changed at 6 o'clock, and the night foreman did not see anything of him. It is supposed that Slako after finishing his work must have gone to the ash dump, where it was warm, and after sitting down either fell asleep or was overcome by the gas from the burning ashes. He had been reclining on a plank, which was partially charred. The whole upper part of Slako's body was burnt.

The coroner's jury brought in the following verdict: "That John Slako came to his death on Monday morning, December 20th, by being burnt while lying in the hot ashes, being probably rendered unconscious by the gases emanating from the partly burnt ashes."

At the railway track of the Canadian Copper Company, on December 12th, 1909, J. Foley, brakeman, was run over and killed. W. Hickey, who was acting conductor on the train, stated that they were making up a load and had tried to make a coupling. Not succeeding in doing this, Foley had signalled for the engineer to go ahead and, on account of the track being downgrade at this point, a string of cars had followed. Foley had apparently stepped in to arrange the knuckle and had walked along between the cars for some little distance, when he was seen by Hickey to throw up his hands and fall. He was found lying diagonally across the main rail and the guard rail, with his face on the outside of the main rail. The front wheel of the hind truck was resting across his back.

The coroner's jury returned the following verdict: "That J. Foley came to his death through a train passing over his body, he having caught his foot in the guard rail while endeavouring to make a coupling. The jury recommend that all guard rails, frogs and switches be properly protected by blocks."

City of Cobalt Silver Mine

An accident occurred at the City of Cobalt silver mine on February 2nd, by which William Stafford, machine helper, fell down the shaft from the second to the third level while attempting to get on the cage. The men were being hoisted out of the shaft a few minutes before 12 o'clock. Stafford was on the second level and, as the cage came from the bottom, the cage tender stopped it, when it was about 5 feet above the level. The cage tender then rang two bells and the cage was lowered to within 18 inches of the station level when, he states, he rang one bell and stopped the cage. He then threw up the guard and one man got on the cage. As Stafford tried to get on, the cage started, throwing him backwards. In falling he caught the edge of the cage and hung on until his head had reached the timber, when the cage was stopped by the cage tender. Stafford almost immediately lost his hold and fell to the bottom of the shaft, sustaining a fracture of the base of the skull, from which he died almost instantly.

An inquest was held and a verdict of accidental death was returned.

Cobalt Central Silver Mine

At the Cobalt Central silver mine, on September 22nd, Elinder Eliason was killed by being struck by the cage as he was passing under the hoistway.

On the morning of the accident the deceased, who had worked only one day in this mine, had had no work assigned to him, but had been told by the captain and the shift boss to stay at the level until a place could be got ready for him. He had been standing at the station for an hour or so, when one of the cars that the cage tender had taken off the cage left the rails. Eliason, who was standing on the opposite side of the shaft from that at which the car had gone off the rails, went round and helped the cage tender put the car on the track. When crossing back, instead of going round the shaft, the way he had come, he crawled under the guard rails and in the act of doing so the cage came down, crushing him under it.

The coroner's jury brought in a verdict "That Elinder Eliason came to his death on September 22nd by being caught under the cage, through his own carelessness, and crushed in the shaft of the Cobalt Central mine."

Cochrane Silver Mine

At the Cochrane silver mine on May 29th, 1909, at 11 a.m., Ranald McDougall and John McDougall were injured by drilling into powder in the bottom of a hole, from which accident Ranald McDougall died on June 10th.

The two men mentioned and two on the opposite shift had a contract for sinking this shaft. The opposite shift had mucked out and, when the McDougall brothers came on shift at 7 a.m. they found everything in good shape. The superintendent, Mr. Floyd Harman, made an examination about 9.30 a.m. and pronounced everything all right. There was little evidence to be obtained as to the cause of the accident. Neither of the men was aware that there was an old hole containing powder until the explosion occurred. The explosion must have been caused either by a cut-off hole, whereby a little dynamite was left in the bottom of the hole, or else by some of the dynamite failing to explode and the men drilling into it.

Crown Reserve Silver Mine

At No. 1 shaft of the Crown Reserve silver mine, on January 5th, 1909, John Shannon, mucker, picked into a piece of gelignite, while mucking in the shaft. The gelignite exploded, causing a fracture of the skull, from which he died on January 8th.

On Friday, January 1st, a round of holes was fired on the Silver Leaf side of the shaft, where the work of taking down the party wall was going on. The rock from the holes went into the shaft, and mucking was carried on here all day Saturday. On Monday morning, about 5 o'clock, a round of holes was fired in the drift from No. 2 to No. 1 shaft which broke through into the latter. From the two rounds, three blasts were reported missing. The men then mucked in No. 1 shaft all day Monday, Monday night and Tuesday until 11.20 a.m. when the accident occurred. A couple of pieces of gelignite had been found in the muck and the captain had warned the men to be careful and to look out for gelignite. However, John Shannon picked into a piece of it, which exploded, causing his death.

The coroner's jury returned the following verdict: "That John Shannon received certain injuries on Tuesday, the 5th day of January, 1909, by picking into unexploded gelignite while working in No. 1 shaft of the Crown Reserve mine, from which injuries the said John Shannon died on the 8th day of January. We recommend that all mines in general, and the Crown Reserve in particular, observe more closely in future the working conditions as presented by the Mines Act, especially as relating to reports of one shift boss to another in regard to missed holes."

At this mine, on July 4th, 1909, Frank Malone, pipe fitter, was overcome by gas, from the effects of which he died about an hour later.

The accident happened on the second level of the No. 1 shaft. Frank Malone and Fred Dyer were sent down to this level about 8.30 a.m. to repair the pump. The drift, run from the bottom of this shaft, was in 60 feet, and a round of holes was fired in this heading at 12 o'clock on Saturday night. No air was blown in here from the time the holes were fired until the two men went down the shaft, when they turned on the air on the first landing. Neither of the men noticed any gas until they got to the bottom of the shaft, but as soon as they began to work both Dyer and Malone were overcome. The men on the first level noticed that something was wrong, and sent for assistance. Malone was the last man to be brought out, about 15 minutes after he went down. A doctor was in attendance shortly after he was brought to the surface, but it was impossible to resuscitate him.

The jury brought in a verdict of accidental death from gas poisoning.

At the same mine, on August 18th, 1909, J. Holland, machine helper, received injuries by being struck on the head with a piece of timber, which resulted in his death on September 15th.

On the day of the accident Holland, with his partner, was engaged in timbering the winze in the east cross-cut. He went to the surface to get some timber, and brought down four pieces, two of them four feet in length and two about nine to ten feet. When the cage with the timber got to the first level, Holland commenced to take off the timber, and was helped by the deck man. The two short pieces had been taken off, and they were engaged in taking off one of the long pieces, when the other piece toppled over on them, striking Holland on the back of the head and fracturing his skull.

The coroner's jury returned a verdict of accidental death.

Davis Silver Mine

At the Davis mine, which is situated on lot 4, in the third concession of Coleman, an accident occurred on January 6th, causing the death of Peter Peterson and injuring Mat Nearmee.

The shaft on this property was 65 feet deep, and was being sunk by hand, hoisting being done by hand whim and derrick. On the night of the accident the men had just gone down the shaft, when Peter Peterson came to the mouth of the shaft and called to the men below that he was going down the rope. He was told by one of the men below to take the ladder, but instead he started to slide down the rope. The rope, which was fastened to the drum of the whim, began to unwind and became loosened and Peterson fell to the bottom, striking and injuring Mat Nearmee, but not seriously. Peterson himself sustained a fracture of the neck and the base of the skull, resulting in instantaneous death.

The coroner's jury brought in the following verdict: "That Peter Peterson was instantly killed between eight and nine o'clock on Wednesday evening, the 7th day of January, at the Davis mine, through falling down the shaft. We recommend, for the safety of miners, that greater care should be taken with whims or other ways of hoisting when prospecting shafts are used, in the way of connecting the cable to such hoisting apparatus."

Deloro Mining and Reduction Company

At the smelter owned by the Deloro Mining and Reduction Company, Deloro, on December 10th, Huski Bokki was killed through being caught in an elevator. Bokki was employed as a laborer on the roasting floor of the smelter. Another employee was engaged in taking the roasted ore in a wheelbarrow to the floor above, using a slowly-moving elevator for hoisting it up. He had put the wheelbarrow on the elevator, stepped on himself, and started it moving. When it reached a height of about five feet he felt it stop, and saw that Bokki's head was caught between the elevator and the first floor. He lowered the elevator and released the man, but it was found that his neck was broken.

Through an oversight on the part of the coroner no inquest was held on this accident.

Elgin Cobalt Silver Mine

An accident occurred on March 30th, 1909, on a prospect shaft located on the north-east quarter of the north half of lot 3, in the twelfth concession of the township of Lorrain, owned by the Elgin Cobalt Development Company, which accident resulted in the death of John P. Bailey. Bailey was working alone in this shaft, which was about 12 feet deep, and had apparently lighted some holes in the shaft and began to climb out, when he was caught by the blast. He was found the next day by some lumbermen, with whom he had been staying. The deceased was lying in the bottom of the shaft, very badly cut up and quite dead.

The coroner's jury returned the following verdict: "That John P. Bailey came to his death on Tuesday, 30th day of March, 1909, while working in a shaft situated on the northeast quarter of the north half of lot 3, concession 12, township of Lorrain, accidentally from an explosion of dynamite."

Farah Silver Mine

At the Farah mine,on September 17th, Euclide Vicente was killed by falling down the shaft from the bucket, while partially overcome by powder fumes.

On the afternoon of the day of the accident the deceased and his partner fired a round of nine holes in the short drift of the 150-foot level. About two minutes after the blast they went down to the 100-foot level, where they started their drill in the heading of the drift, about 70 feet from the shaft. They remained down about twenty-five minutes, when the hoistman got one bell to hoist. He hoisted slowly, and, when the bucket was about twenty feet above the level, he got one bell to stop. The deckman noticed that something was wrong, and told him to hoist to the surface slowly. When the bucket reached the surface the partner of the deceased was found hanging over the side of it, quite unconscious. He was taken up, and revived some time after. Two of the men then went to the 150-foot level, where they found Vicente dead, his skull having been very badly fractured. The deceased was in the employ of Damos Gauthier, who had the contract for the work being done at this shaft.

Gowganda United Silver Mine

An accident occurred on claim M.R. 1961, owned by the Gowganda United Mines, Limited, on March 21st, 1909, causing the death of Thos. Douglas and injuring Amos Dummett. The men were employed on a prospect, the work being in charge of Amos Dummett. As far as could be learned, Douglas and Dummett were in the building used as a blacksmith shop, thawing dynamite over the fire in a can. An explosion occurred, causing serious injuries to Douglas, which resulted in his death a month later.

No inquest was held on this accident on account of there being no coroner at Gowganda at the time, and the impossibility of one going in at that season of the year.

Helen Iron Mine

At the Helen iron mine, on September 9th, Jaakop Korkiamaki and Granz Mannila were killed by a fall of ground in No. 5 stope on the fifth level.

On the day of the accident the two men mentioned drilled one hole during the forenoon and fired it when going off shift. After noon they both went into the stope, and after apparently doing but little scaling they set up their machine and started to drill. About 2.45 p.m. a mass of ore, weighing approximately 50 tons, fell, crushing both men under it. On examination of the stope it was found that there was a soft slip on the side, from which the ore fell, above which was loose ground composed of soft granular pyrite and calcite. This slip was the main cause of the accident. The hole fired by the men when going off shift had taken away the support for this mass of ore.

The coroner's jury returned the following verdict: "That Jaakop Korkiamaki and Granz Mannila came to their death by a fall of ground from the wall of stope No. 5, but there was no evidence of culpable negligence on the part of any employee of the Helen mine. The manner of their deaths was accidental."

James Mine

At the James mine, situated on lot 24, in the eleventh concession of Madoc township, Hastings county, an accident occurred on March 5th, 1909, resulting in the death of Daniel Phillips and Felix Allard and injuries to George Young and John Moore.

This property is owned by the James Company, Limited, of which Mr. W. A. Hungerford, of Madoc, was resident manager. At the time of the accident the work was being done by Robert Phillips, who had a contract for sinking a shaft from a depth of 20 feet to a depth of 70 feet. Mr. Phillips employed his own men, and was paid every two weeks for the amount of sinking he had done.

On March 4th, five holes, which had been drilled in the shaft by hand, were blasted about noon, giving five reports. After the round, Robert Phillips, contractor, went into the shaft to examine the ground and see if everything was safe. During the rest of this

day the men were engaged in mucking out the shaft. On the morning of March 5th Phillips went down in the shaft with the four men mentioned above, and pointed out two holes for them to drill. He went to the surface and came down into the shaft again about nine o'clock, just as the explosion occurred, with the result mentioned above. On examination it was found that two of the men had completed the hole that had been pointed out to them, and had begun to drill another one, which was the old bottom of one of the holes fired the previous day. It appears that there had been a slip about three or four inches above the bottom of the hole, and the top part had been cut off, leaving the powder in this hole.

The coroner's jury returned the following verdict: "That Daniel Phillips came to his death on Friday, March 5th, 1909, in the shaft of the mine owned under option by the James Mining Company. We also found his death was caused by an accidental explosion, and no blame can be attached to anyone connected with the said mine. We also further recommend that a regulation be added to the Mining Act prohibiting the drilling in an old hole."

Laurentian Gold Mine

At the Laurentian gold mine, on April 26th, Jacob Nyman, machine runner, was killed while loading a hole with gelignite. It appears that Isaac Nyman, who was about twelve feet from the deceased, after taking the paper off the gelignite, had handed the deceased two sticks of gelignite, one of which the deceased put in the hole. This stuck about 4½ feet from the collar of the hole, and the deceased was trying to push it to the bottom when the explosion occurred. The hole was about seven feet deep.

The evidence of the helper showed that when drilling the hole they had difficulty with it when about this depth, which would probably account for the trouble the deceased had in getting the stick to the bottom of the hole. The superintendent stated that he had always found Jacob Nyman a careful, hard-working and efficient miner. The accident must have been caused by the gelignite sticking in the drill hole, which was probably a little rough at this point, and by the deceased, Jacob Nyman, using too much force in trying to get it to the bottom of the hole.

The coroner's jury returned a verdict of accidental death.

Mayo Iron Mine

At the Mayo iron mine, operated by the Canada Iron Corporation, on December 15th, 1909, Pasquali Maiurino, mucker, was killed by being crushed under a large piece of falling ore. The deceased was an Italian, engaged as a mucker on the second level. A round of holes had been fired in the side of the winze about twelve o'clock. At one o'clock the men came on shift. The machine men scaled down where they were underhand stoping, and three of the muckers did some scaling on the second level under the ground where the blast had taken place. After these three men had scaled for about half an hour they began to muck. About half an hour afterwards a piece of ground, weighing about 300 pounds, fell, striking Maiurino and injuring him so seriously that he died a few hours later.

The coroner's jury returned the following verdict: "That Pasquali Maiurino came to his death on the 15th day of December, in the drift in Mayo mine No. 4, operated by the Canada Iron Corporation under lease from the Mineral Range Iron Mining Company. His death was caused by a large piece of ore accidentally falling from the roof of the drift and hitting him."

McKinley-Darragh Silver Mine

At the McKinley-Darragh mine, on March 17th, 1909, Robert Johnson, machine runner, was killed while loading a hole with gelignite. On the night of the accident Johnson, who had drilled four holes with an air hammer drill, about 11.30 went to the powder house to get a supply of powder to load seven holes, three of which had been drilled by the opposite shift. He was seen coming up with the powder about fifteen minutes before the accident occurred. The machine man and helper working in the drift

near the deceased heard a shot, and concluded that the deceased was firing a round. No notice was taken until at supper the shift boss noticed that the man was missing, and, going down, found him in the stope covered with rock and quite dead. On examination of the back where he had been working, it was found that he had loaded four holes, and was apparently loading the fifth when the explosion occurred. On account of the position of the hole, which was in the back of the stope nearly vertical, it was impossible to arrive at any satisfactory explanation of the cause of the accident. The deceased was apparently pushing the gelignite into the hole with a wooden tamping stick when the explosion occurred. It would therefore appear that the explosion was caused by the friction between the rock and the gelignite while putting it into the hole.

The coroner's jury returned the following verdict: "That Robert Johnson came to his death on Wednesday, 17th day of March, 1909, in the stope of the McKinley-Darragh mine, and that the cause of the death of the said Robert Johnson was an accidental explosion of gelignite."

At the same mine, on April 24th, 1909, George Watson, otherwise known by the name of Geo. W. Puckett, machine runner, was killed by an explosion in the raise in which he was working.

A round of holes had been fired in this raise on Saturday morning, and three holes were reported missing. On Saturday morning the shift boss gave instructions to have these three missed holes fired at twelve o'clock. These were fired along with another, and one reported short. On Saturday night Watson started to work, and about an hour after an explosion occurred. It would seem that the deceased had begun to drill in one of the old bottoms, which happened to be a missed hole, thus causing the explosion.

The coroner's jury brought in the following verdict: "That George Watson or George W. Puckett came to his death at the McKinley-Darragh mine by an explosion caused by lack of method in ascertaining missed holes, and we recommend that there be more stringent reports made by one shift boss to another, and that fully experienced men be engaged as shift bosses and captains."

On December 1st, 1909, Costea Ruciarz, mucker, was instantly killed by picking into a piece of gelignite in the muck. The accident occurred about 3.30 p.m., in a drift at the 75-foot level of No. 1 shaft. About two days prior to the accident a cut-off hole had been discovered in the cross-cut, which was only about six feet in length. This cut-off hole was fired as soon as found, but a couple of sticks of gelignite must have been left in the muck. About twenty minutes before the explosion the deceased's partner found a piece of gelignite in the muck and laid it to one side. Just a few seconds before the accident Ruciarz was seen picking in the muck, and must have struck another piece of gelignite, which exploded.

The coroner's jury returned the following verdict: "That Costea Ruciarz came to his death by an explosion of powder in the muck, and the death was accidental. The jury recommend that definite instructions be given to muckers to have all powder found by them conveyed to some safe place."

Moose Mountain Iron Mine

At the Moose Mountain iron mine, on December 30th, 1909, J. Depilon was killed while walking over a pit where a blast had been lighted. The men were engaged in blasting out rock for a foundation. The fuse was lighted, and the captain and the powder man shouted "fire," and all ran to a place of safety. It would seem that at this time Depilon came to the place of blasting from a distant point where construction work was also being carried on, and evidently had not heard the cry of "fire." He was crossing an 18-inch plank over the pit, when the blast went off. Depilon was thrown into the air, and lighted on his head in the pit, a fall of eight or ten feet. He was taken to the hospital at Sudbury, but died a few minutes after reaching there.

The coroner's jury brought in a verdict "That J. Depilon was accidentally killed, and that there could be no blame attached to anyone."

Northland Pyrites Mine

At the Northland pyrites mine, on March 5th, 1909, Aleck Hebrik, machine runner, was instantly killed by falling through timbers into the stope below. Four men were employed in blasting in the north stope of the 100-foot level. The stope was being carried as an underhand stope from the level, and the floor of the level had been timbered across to protect the men, and also to afford access to the far end of the stope. Immediately after the blast Hebrik started to walk across this timber. Some of the men warned him not to do so, as the smoke from the blast was so thick that it was impossible to see in front of him. He, however, continued across the timber until he came to a place where the blast had cut away a stull, leaving a hole in the timber. On account of the smoke Hebrik could not see the hole, and fell into it, being killed instantly.

The coroner's jury returned the following verdict: "That Aleck Hebrik came to his death on the 5th day of March, 1909, about 11.45 p.m., and such death was accidental."

Mond Nickel Company

Victoria Mines

At the smelter at Victoria mines, operated by the Mond Nickel Company, on September 12th, 1909, Fred Guran and John Bezmutke were killed by the explosion of the settler of No. 1 furnace. This settler was about 12 feet in diameter and about 4 feet high, with 12 inches of lining composed of magnesia, brick, clay and quartz. About five minutes before the accident occurred a ladle full of matte had been tapped off, which left the settler about half full of matte and slag. The night foreman and the tapper were standing alongside the settler when they heard a slight explosion. They immediately called to the three men, who were eating their lunch nearby, to go to a place of safety. A few seconds afterwards a very violent explosion occurred, throwing down the walls of the settler and covering the two men, Guran and Bezmutke, with matte and slag, from which burns they died a few hours afterwards.

The coroner's jury brought in the following verdict: "That Fred Guran and John Bezmutke came to their death as the result of an explosion which was accidentally caused by a defective settler."

Garson Mine

On September 17th, 1909, at the Garson nickel mine, owned by the Mond Nickel Company, Wm. Scott, cage tender, was killed by falling down the shaft.

Scott had attempted, with the assistance of two other men, to right a misplaced car on the cage at the first level, and had climbed over the car to the rear of the cage to lift it. Before all was clear, someone unknown, rang the regulation hoisting signal. Feeling the cage moving, Scott attempted to step off on a timber, missed his footing, and fell to the fifth level. He was killed instantly.

The coroner's jury brought in the following verdict: "That Wm. Scott came to his death from accidental causes. No blame can be attached to any employees of the company."

Nipissing Silver Mine

At the Nipissing silver mine, on May 25th, 1909, John Pirttinen, timberman's helper, was killed by falling from the bucket down the shaft.

Deceased and John Olliakinen, timberman, had been timbering the shaft on the 200-foot level. At about 8.30 a.m., noticing a little gas, they came up to the first level, and remained there about half an hour. After going back to the second level they took out the hanging rods of the station set, put them in the bucket, and then both men got on the bucket and rode to within two feet of the platform of the first level. Some of the rods being 16 feet long, the bucket was stopped below the first level, as the hoist man was afraid of the rods catching in the sheave wheel. When the bucket was stopped the timberman got out, and was looking up to see if the bucket could be hoisted any higher

without the rods catching, when he noticed his partner falling out of the bucket into the shaft. It was supposed that the deceased had started to get out of the bucket, but in so doing slipped and fell backwards into the shaft.

The coroner's jury brought in the following verdict: "That John Pirttinen came to his death on Tuesday, 25th May, 1909, at the Fourth of July shaft of the Nipissing mine, by accidentally falling out of the bucket."

At the same mine, on June 15th, 1909, Alerio Marinelli, laborer, was killed in a trench through being struck by a boulder. The trench in which the deceased was working was about eleven feet deep, the upper four and a half feet being of peat, and the lower six and a half feet very hard dry clay, with a number of boulders through it. A boulder, weighing from 300 to 400 pounds, which protruded about eight inches into the trench at a distance of about three and a half feet from the bottom, fell out, striking the deceased on the side and knocking him over against the other side of the trench, his head coming in contact with a small boulder, also imbedded in the clay. The fall of the large boulder loosened a lump of clay above, weighing about 150 pounds, which descending struck Marinelli on the head and fractured his skull. He was taken to the Red Cross hospital, and died five hours later.

On November 30th, 1909, Alfred Silvola, machine runner, was instantly killed while loading a round of holes in a raise at the Fourth of July shaft. While loading the holes the dynamite, in some manner unable to be determined, caught fire and exploded, killing Silvola instantly. Allan Carswell and Wm. Kokka were in the shaft about thirty feet below, and were slightly injured. These two men gave evidence that some burning powder had dropped down from the raise a few seconds before the accident, and that the raise was flooded with light from the burning powder.

The coroner's jury brought in a verdict of accidental death.

Nova Scotia Silver Mine

At the Nova Scotia mine, on July 8th, 1909, Samuel Chislett, machine runner, was killed by being caught between the cage and the timber in the shaft.

Chislett was running a drill in a drift about fifty feet from the shaft on the fifth level. About ten minutes before the accident he went out of the drift to the station, about ten feet from the shaft, to talk to Grant Dempster, boss carpenter. Dempster got on the cage and told S. Clarke, carpenter, to get on with him and go to the next level. After Clarke had got on, Dempster rang the cage to the fourth level. The cage was not raised for about thirty seconds, and during this interval of time Chislett, who had made no mention of wanting to go to the surface, made a run for the cage. Dempster called to him to go back, but he paid no attention and tried to climb on under the bar just about the time the cage started. He got about half on when the cage got to the top of the station set, where he was caught between the timber of the station set and the cage. The latter was stopped and lowered, and it was found that Chislett was very seriously injured about the hips and legs. He was taken to the hospital, and died about 12.15 a.m. on July 9th.

The coroner's jury brought in a verdict of accidental death.

On February 12th, Napoleon Tayer, laborer, was killed by the falling of frozen rock, under which he was working, at the dump of the Nova Scotia mine. The deceased was employed by C. F. Price, contractor, who had a contract for hauling rock from the Nova Scotia dump to the Northern Customs Concentrator. The deceased had been warned the day before by contractor Price not to work under the frozen ground, but he persisted in doing so, and as a result lost his life.

The coroner's jury brought in the following verdict: "We find that the deceased, N. Tayer, met his death at the Nova Scotia mine dump by rock accidentally falling upon him on February 12th, 1909."

O'Brien Silver Mine

At the O'Brien silver mine, on April 2nd, 1909, Herbert Cooper, machine helper, came to his death from inhaling poisonous gases after firing a round of holes with a new variety of dynamite manufactured by the Northern Explosives Company, Limited.

The deceased was working in a cross-cut in No. 1 shaft. At twelve o'clock he and his partner fired a round of holes, using 66 sticks of powder. At one o'clock the deceased went into the heading with Howard, machine man. Howard came out in about five or ten minntes suffering from the effects of gas. The shift boss went in the cross-cut and found Cooper unconscious. He was brought out and taken to the surface, and thence to the hospital. There he lingered in an unconscious condition for about five hours, resisting all the efforts of the doctors to bring him round, and died about six o'clock. The doctor stated that he was of the opinion that carbon monoxide was the predominating constituent of the gas that caused the death.

The coroner's jury returned the following verdict: "That Herbert Cooper was overcome by gas in the O'Brien mine and died from the effects of it abont six o'clock on the same day. Tbe death of the said Herbert Cooper was accidental, and no blame can be attached to the company or to any of the officials."

At the same mine, on May 4th, Joseph Scott, machine helper, was killed by slipping from the bucket and falling from the first to the second level.

At 7 a.m. Scott, with Richard McCandie and John Ross, got on the bucket at the collar of No. 2 shaft to ride to the first level. McCandie and Ross were in the bucket, and the deceased was standing on the cross-head. When the bucket reached the level the engineer stopped it, and McCandie and Ross got out. Scott climbed down from the cross-head to the rim of the bucket, and, in getting from the bucket to the station platform, he slipped and fell to the second level, a distance of 100 feet. He was picked up and found to be in a partially unconscious condition. He was moved to the hospital, where it was found that the thorax and ribs on the right side were broken. He died at about 9.45 a.m.

An information was laid before Magistrate Atkinson against Richard McCandie and John Ross for violation of section 164, rule 23, of the Mining Act of Ontario. The case was heard at Cobalt on Tuesday, May 11th, at 3 p.m. The men pleaded guilty, and were each fined $10.00 and costs.

Rochester Silver Mine

At the Rochester silver mine, on December 29th, 1909, Ernest Edward Burley, machine runner, was killed by an explosion while firing a round of holes in the cross-cut from the main drift about 125 feet west of the shaft on the first level. The deceased, helped by his brother, Wm. Burley, had loaded a round of eight holes and fired them about 11.30 p.m. They had mucked back, and found that about two feet of each hole was left. They then reloaded the holes, putting about two sticks of explosive in each, and Burley was in the act of firing these holes when an explosion took place which injured him fatally, his death occurring about seven hours later. Before Burley died he said that in lighting the holes he was caught by a "quick fuse." There was no evidence, however, to support the injured man's contention, nor was there any evidence to show that the holes were tamped after being loaded, and from the evidence of Wm. Burley it was shown that in some of the holes the powder came within three inches of the collar of the hole. The fuse was manufactured by Bennett & Sons, and was in good condition. The powder used was manufactured by the Northern Explosives Company. From comparison with some similar accidents that have occurred in Ontario, it would appear that the explosion was caused by the fuse of one of the holes after it was lighted, spitting into the powder of another hole which had not been tamped.

The coroner's jury brought in the following verdict: "That Edward Burley came to his death on December 29th, at the Rochester mine, by the premature burning of a fuse

which caused the dynamite to explode too quickly, and we accordingly find a verdict of accidental death. We strongly recommend that the Federal Government enact a law compelling the inspection of all explosives, fuse and caps."

Sulphide Pyrites Mine

At the Sulphide pyrites mine, owned by the Nicholls Chemical Company, on July 5th, 1909, Percy Davey, machine runner, was killed by a premature blast in the winze.

A round of nine holes had been drilled in this winze, which was 20 feet deep, during the day shift, and when Davey and his partner came to work they proceeded to load the round. The helper stated that the nine holes were loaded with four sticks each of 40 per cent. dynamite, and that in loading the holes the deceased did not use any tamping in eight of them. After the nine holes had been loaded, his helper was sent to the top of the winze, and Davey proceeded to light the holes. The helper saw him start to light the round, when an explosion instantly occurred. On examining the winze after the accident it was found that all the holes had exploded except one. It would appear that the fuse, after being lighted, had spit in one of the untamped holes, causing a premature explosion.

The coroner's jury brought in a verdict of accidental death.

Temiskaming Silver Mine

At the Temiskaming silver mine, on March 3rd, 1909, Ainslie Patriquin was instantly killed while mucking out the shaft subsequent to blasting. A round of holes had been fired and all reports received, but Patriquin, while mucking, struck his shovel against some unexploded gelignite, which exploded. Patriquin had been in the employ of the company for a year, and was said to be an experienced miner.

An inquest was held, and a verdict of accidental death returned.

At the same mine, on August 6th, 1909, Frank Crean, machine man, was killed by being struck on the head with a rock falling from the bucket while engaged in sinking the shaft.

Four men, namely, Ben Lewis, A. J. McNeill, B. Barnes and William Stephenson, had a contract for sinking No. 2 shaft from the 300-foot level, a depth of 50 feet. On the night of the accident the deceased was working in the shaft with Ben Lewis and A. J. McNeill. A round of holes had been fired on the previous shift, and the men were engaged up to the time of the accident in mucking out the shaft. The shaft contained two hoisting compartments and a ladderway, the north hoisting compartment being used at this time exclusively for sinking the shaft. A pentice had been put in under the hoistway and the ladderway at the 250-foot level. This pentice protected the men in the shaft from anything falling down the ladderway or the south hoisting compartment, and covered two-thirds of the shaft. The north hoisting compartment was for the bucket used in mucking out the shaft. At the time of the accident four men were engaged shovelling into the bucket, two of them being under the bucket way and two of them protected by the pentice. The bucket had been loaded, and, in going to the surface, a piece of rock fell out. It fell to the bottom, striking Frank Crean on the head, killing him instantly. The shaft was provided with proper guides and cross-head.

The coroner's jury brought in a verdict "That Frank Crean was killed owing to defective gear in the shaft."

Table of Fatal Accidents in 1909

Date.	Name of Mine.	Name of Owner.	Name and Occupation of Injured.	Below ground.	Above ground.	Nature of Injury.	Cause of Accident.
Oct. 6..	Blast furnace	Algoma Steel Co	Henry Foster, labourer		1	Windpipe and jugular vein severed	Explosion, while blasting hot salamander in blast furnace.
June 22..	Badger	Badger Mines Co., Ltd	Henry Davis, teamster		1	Fracture of skull	Caught between cage and timbers of shaft house.
Oct. 15..	Big Six	Big Six Silver Mines, Ltd.	J. M. McGillivray, machine runner	1		Badly shattered	Caught by explosion while lighting holes in shaft.
July 22..	Bruce	The Bruce Mines, Ltd.	Gus Matilla, machine runner	1		Back broken and spinal cord severed.	While ascending shaft on cage, caught between cage and timbers.
Jan. 19..	Crean Hill	Canadian Copper Co.	Edward Salmet, machine runner	1		Killed instantly	Inserted iron blow-pipe into missed hole, causing explosion.
April 15..	do	do	Kalli Jarvis, machine helper	1		Skull fractured	Struck by piece of falling rock.
June 22..	do	do	Mike Bekic, trammer	1		Injury to head	Struck by piece of falling rock.
Sept. 18..	Smelter yards	do	Mariphetto Giovanni, labourer		1	Chest crushed, and internally injured	Run over by train.
Nov. 4..	Creighton	do	Adanti Anabel, crusher man		1	Fracture of base of skull	Bag of powder, sent down in skip, not taken out; car of ore dumped on it, and hoisted to rock house, where it exploded.
Dec. 12..	Railway track at Copper Cliff	do	J. Foley, brakeman		1	Badly crushed	While making a coupling, slipped and run over.
Dec. 15..	Crean Hill	do	Koski Johnson & Dom. Dale, miners.	2		Injuries to head	Explosion of gelignite, while barring down loose rock.
Dec. 20..	Smelter yards	do	John Slako, labourer		1	Burned to death	Lay down on cinder pile; was overcome by gas, and burned to death.
Feb. 2..	City of Cobalt	City of Cobalt M'g. Co. Ltd.	William Stafford, machine helper	1		Base of skull fractured	Fell down shaft, while attempting to get on cage in motion.
Sept. 22..	Cobalt Central	Standard Cobalt Mines Ltd.	Elinder Eliason, machine helper	1		Body crushed	Crushed under cage while crossing hoistway.
May 29..	Cochrane	Cochrane Cobalt M'g. Co.	Ranald McDougall, machine runner.	1		Compound fracture of right leg, wounds in thigh & groin	Drilled into old hole containing dynamite.
Jan. 5..	Crown Reserve	Crown Reserve M'g. Co. Ltd.	John Shannon, mucker	1		Fracture of skull	Picked into a piece of gelignite while mucking, which exploded.
July 4..	do	do	Frank Malone, pipe fitter	1		Asphyxiated	Overcome by gas from powder fumes.
Aug. 18..	do	do	J. Holland, machine helper	1		Fracture of base of skull	Timber fell off cage, striking him on back of head.
Jan. 6..	Davis	H. P. Davis, et al	Peter Peterson, miner	1		Fracture of neck and base of skull.	While sliding down rope into shaft, rope unwound off whim, allowing deceased to fall to bottom.
Dec. 10..	Smelter	Deloro Min. & Reduction Co	Huski Bakki, labourer		1	Neck broken	Caught in elevator.
Mar. 30..	N-E ¼ of N ½ lot 3, con. 12, Lorrain	Elgin Cobalt Dev't Co	John P. Bailey, miner	1		Badly cut about the head	Found alone in prospect shaft, having apparently been caught by blast after lighting a round of holes, while climbing out of shaft.
Sept. 17..	Farah	Farah Mining Co., Ltd.	Euclide Vicente, machine helper	1		Skull smashed	Fell from bucket while ascending shaft, when partially overcome by gas.
Mar. 21..	M.R. 1961	Gow Ganda United Mines, Ltd.	Thos. Douglas, miner		1	Badly cut in the groin, dying a month later	Thawing dynamite in can over fire.
Sept. 9..	Helen	Lake Superior Power Co	Jaakop Korkiamaki and Granz Mannila, miners	2		Compound fractures of skull	Fall of ore.
Mar. 5..	James	James Co., Ltd	Dan. Phillips and Felix Allard, miners	2		Killed instantly	Drilled into bottom of old hole containing unexploded dynamite.
April 26..	Laurentian	Imperial Gold Mines, Ltd.	Jacob Hyman, machine runner	1		Skull fractured	Explosion while charging round of holes, preparatory to blasting.
Dec. 15..	Mayo	Canada Iron Corporation	Pasquali Maiurino, mucker	1		Legs crushed	Fall of ore.
Mar. 17..	McKinley-Darragh	McKinley-Darragh-Savage Mines, Limited	Robt. Johnson, machine runner	1		Killed Instantly	Premature explosion of gelignite while loading hole.
April 21..	do	do	Geo. W. Puckett, machine runner	1		Killed Instantly	Supposedly drilled into bottom of old hole containing unexploded powder.

Table of Fatal Accidents in 1909—Concluded.

Date.	Name of Mine.	Name of Owner.	Name and Occupation of Injured.	Below ground.	Above ground.	Nature of Injury.	Cause of Accident.
Dec. 1	McKinley-Darragh	McKinley-Darragh-Savage Mines, Limited	Costea Ruciatz, mucker	1	....	Head smashed	Picked into piece of gelignite in muck.
Dec. 30	Moose Mountain	Moose Mountain, Ltd.	J. Depilon, labourer	....	1	Skull fractured	Walked over place where blast was being set off.
Mar. 5	Northland	Northland M'g. Co.	Alex. Hebrik, machine runner	1	....	Killed instantly	Fell through hole in timbers after blast.
Sept. 12	Smelter	Mond. Nickel Co.	John Bezmutke and Fred Guran, labourers	....	2	Burned by molten matte	Explosion of settler of furnace.
Sept. 17	Garson	do.	Wm. Scott, cage tender	1	....	Badly smashed	Fell down shaft.
May 25	Nipissing	Nipissing M'g. Co.	John Puttinen, timberman's helper	1	....	Skull fractured	Fell from bucket while attempting to get out at level.
June 15	do.	do.	Alerio Marinelli, labourer	....	1	Fracture of skull	While working in trench struck by boulder which fell from side of trench.
Nov. 30	do.	do.	Alfred Silvola, machine runner	1	....	Killed instantly	Premature explosion while loading round of holes.
July 8	Nova Scotia	Nova Scotia Silver Cobalt Mining Co.	Samuel Chislett, machine runner	1	....	Hips and legs crushed	Caught between cage and shaft timbers.
Feb. 12	do	C. F. Price, Contractor	Napoleon Tayer, labourer	....	1	Killed instantly	Fall of frozen rock on dump.
April 2	O'Brien	M. J. O'Brien	Herbert Cooper, machine helper	1	...	Asphyxiated	Overcome by dynamite fumes.
May 4	do.	do.	Joseph Scott, machine helper	1	....	Thorax and ribs broken	Fell from bucket down shaft 75 feet.
Dec. 29	Rochester	Rochester Cobalt Mines, Ltd.	E. Burley, machine runner	1	....	Severely injured under left arm and side	Premature explosion.
July 5	Sulphide	Nicholls Chemical Co.	Percy Davey, machine man	1	....	Skull fractured and body shattered	Explosion while lighting round of holes.
Mar. 3	Temiskaming	Temiskaming M'g. Co.	Ainslee Patriquin, machine man	1	....	Killed instantly	Picked into unexploded gelignite in muck.
Aug. 6	do.	do.	Frank Crean, machine man	1	....	Skull fractured	Rock fell from bucket and struck deceased on head.
			Total	36	13		

Table of Non-Fatal Accidents in 1909

Date.	Name of Mine.	Name of Owner.	Name and Occupation of Injured.	Below ground.	Above ground.	Nature of Injury.	Cause of Accident.
May 29	Cochrane	Cochrane Cobalt M'g Co.	John McDougall, machine runner	1	....	Flesh wound about face	Drilling into old hole containing dynamite.
Feb. 17	Coleman Dev'l.	Coleman Dev't Co., Ltd.	Noble Farnam, machine helper	1	....	Face cut	Picked into gelatine dynamite in muck.
Dec. 15	Crean Hill	Canadian Copper Co.	J. Cappotice, boss trammer	1	....	Face injured	Explosion of gelignite while barring down loose rock.
Jan. 5	Crown Reserve	Crown Reserve M'g Co.	S. Chapple, deckman	....	1	Wound in face	Struck by piece of steel he was taking off cage.
Nov. 29	do	do	R. Vacha, carpenter	1	....	Sprained back	Steel plate fell on him from cage.
Dec. 21	do	do	A. Griffin, machine runner	1	....	Lower jaw broken and eyesight injured	Picked into piece of gelignite in bottom of drift.
			E. Desmond, machine helper	1	....	Slight face injuries	
Jan. 6	Davis	H. P. Davis, et al.	Mat Nearmee, miner	1	....	Back and thighs bruised	Peter Peterson fell down shaft and struck him.
April 17	Devlin	Devlin Mining Co., Ltd.	H. Miren, miner	1	....	Both legs broken	Drilled into bottom of old hole containing unexploded dynamite.
			P. Mercier, miner	1	....	Injuries to eyes	
			A. Mercier, miner	1	..	Both legs broken	
Mar. 21	M. R. 1931	Gowganda United M's, Ltd	Amos Dummett, miner	....	1	Cuts on body	Thawing dynamite in can over fire.
Jan. 19	Hargraves	Hargraves Silver M's, Ltd.	John Chenoweth, mine captain	1	....	Collar bone broken	While timbering in shaft staging gave way, precipitating him twenty-five feet.
July 5	do	do	Wm. Woodworth, machine runner	1	....	Broken leg	Machine fell on his leg.
Jan. 6	Helen Mine	Lake Superior Power Co.	Pietro Boni, miner	1	....	Scalp wounds and fractured knee cap.	Struck by piece of ore, which knocked him into raise and down to fourth level.
Jan. 9	do	do	Steve Spostala, trammer	1	....	Scalp wound	Struck on head by piece of falling ore.
Jan. 13	do	do	C. Agnese, trammer	1	....	Finger crushed	Caught finger in ore car when dumping it.
Jan. 22	do	do	Emelis Boni, machine man	1	....	Finger crushed	Caught finger in drill.
Dec. 9	do	do	A. Knuuttila, miner	1	....	Face and hands cut and eyes injured.	Picked into dynamite in missed hole.
Aug. 21	do	do	John Baltovin, machine runner	1	....	Fingers crushed	Fingers caught in machine.
May 22	do	do	Jelvar Lake, machine runner	1	....	Injured in right side	Struck by piece of ore.
Nov. 3	do	do	Wm. White, machine man	1	....	Sprained ankle	Struck by ore, causing him to fall down stope.
Mar. 5	James	James Co., Ltd.	Geo. Young, miner	1		Badly cut by flying rocks from explosion	Drilled into bottom of old hole containing dynamite.
			John Moore, miner	1			
Mar. 1	Kerr Lake Majestic	Kerr Lake Majestic M'g Co., Ltd.	Walter Olsen, miner	1	....	Head cut	Went back to shaft too soon after blast, and was injured by explosion.
Jan. 9	La Rose	La Rose Mines, Ltd.	Geo. Dion, miner	1	....	Leg broken	Loose rock fell on him from roof of drift.
April 11	do	do	A. H. Derry, master mechanic	....	1	Leg broken	Fell on surface.
April 15	do	do	Gideon Houle, miner	1	....	Lacerated hand	Hand caught between piece of falling rock and scaling bar.
July 28	do.	do.	Martin Kudla, mucker	1	....	Back bruised	Rock rolled against him from side of drift.
Sept. 21	do.	do.	John McCarty, miner	1	....	Bruised	Rock fell on him while scaling.
June 29	Victoria	Mond Nickel Co.	Chas. Hill, machine man	1	....	Scalp wound	Struck on head by piece of rock while working in shaft.
Nov. 30	Millerett	Millerett Silver Mines	Thos. Girard, miner	1	....	Broken arms and flesh wounds	Fuse spit on powder in untamped hole.
June 23	North Lanark Marble Quarry	North Lanark Marble and Granite Quarry Co.	T. Sweeney, labourer	....	1	Broken nose and scalp wound	Struck by crank of hand winch.
Nov. 30	Nipissing	Nipissing M'g. Co.	Wm. Kokka, Allan Carswell, machine men.	2	....	Scalp wounds	Cut by flying rock in explosion in which A. Silvola was killed.
June 10	O'Brien	M. J. O'Brien	John Hipworth, machine helper	1	....	Loss of eyesight	Drilled into bottom of old hole which contained dynamite.
			Willis Fry, machine runner	1	....	Injury to abdomen	

Table of Non-Fatal Accidents in 1909—Concluded

Date.	Name of Mine.	Name of Owner.	Name and Occupation of Injured.	Below ground.	Above ground.	Nature of Injury.	Cause of Accident.
Jan. 30	Right of Way	Right of Way M'g. Co.	Wm. Steinkiewicz, trammer	1	....	Leg broken	Struck by piece of rock, while rock was being scaled.
June 28	Bruce	The Bruce Mines, Ltd.	A. Puskala, machine runner	1	...	Flesh wounds	Struck piece of unexploded gelignite with pick.
			Vic Ogi, machine helper	1	....	Flesh wounds and left eye destroyed.	
July 7	do	do.	E. Lilius, machine runner	1	....	Injuries to face and eyes	Struck an unexploded charge of gelignite with pick.
			F. Gugins, machine helper	1	....	Slight flesh wounds	
Oct. 27	Trethewey	Trethewey Silver Cobalt Mines, Ltd.	S. Sawzick, mucker	1	....	Eyes injured, also face and hands.	Shovel struck loose dynamite in muck.
Nov. 1	Temiskaming	Temiskaming Mining Co. Ltd.	C. Davis, machine runner	1	....	Broken ankle	Before engineer was at hoist men got on cage, which descended shaft uncontrolled.
			W. White, machine runner	1	....	Sprained knee	
Dec. 27	do.	do.	R. A. McBeth, electrician	....	1	Leg broken	Fell from one floor to another in the mill.
			Total	11	5		

MINES OF ONTARIO

By E. T. Corkill, Inspector of Mines

I.—NORTHWESTERN ONTARIO

Actual mining work in northwestern Ontario in 1909 was confined chiefly to the Upper Manitou lake area, Sturgeon lake, Northern Pyrites mine, and the silver mines tributary to the Port Arthur and Duluth railway. The Atikokan iron mine was in operation all summer, as was also the blast furnace of the Atikokan Iron Company at Port Arthur. The Dominion Bessemer Ore Company shipped a couple of cargoes of iron ore from their property in the township of Macgregor, twenty-two miles east of Port Arthur, at the head of Thunder bay. A number of claims were taken up for iron ore near Lake Savant during the year, and considerable prospecting for gold was done in the Sturgeon lake area. Captain H. A. C. Machin, of Kenora, having taken an option on the old Mikado gold mine, has had it pumped out, and is examining it thoroughly. If active mining work is resumed at this property, we may look for further activity in Lake of the Woods.

Upper Manitou Lake Area

It is to be regretted that the owners of the Laurentian mine got into financial difficulties in November, 1909, as a result of which the mine was placed in the hands of a receiver and ordered to be sold. At present the mine is lying idle.

The Paymaster mine also closed down during December, 1909.

Laurentian Gold Mine

Work was carried on continuously until it was sold by the receiver. The purchasers have not done any work as yet.

The developments since the last Report have consisted chiefly in sinking a winze from the drift on the fourth level about 80 feet north of the shaft, a depth of 80 feet, and drifting from the bottom of the winze about 50 feet north and south. The drifts on the fourth level were continued to distances of 200 feet north and 150 feet south of the shaft. Between the third and the fourth, and also between the second and the third levels north of the shaft, considerable stoping was done.

A 6-inch pipe has been laid from the mill to Upper Manitou lake, nearly a mile distant, to supply water to the mill. The 20-stamp mill was kept running day shift the greater part of the year.

Mr. R. B. Nickerson was superintendent in charge, employing on an average thirty men.

The closing down of this property, which was considered by the public the mainstay of the district, is unfortunate, as it retards the investment of capital in other properties near, and discourages other companies attempting to develop paying mines.

Paymaster Gold Mine

The work done at this mine, beyond that described in the last Report, consists chiefly of drifting on the second and third levels. On the third level the drift has been driven north 175 feet from the shaft, and south 25 feet. Only one drill was operated underground for part of the year. Work at erecting a 10-stamp mill was under way. A cage was on the ground ready to be put in the shaft when all work closed.

Mr. Geo. Thow was superintendent in charge.

Detola Gold Mine

The Detola Mining and Development Company were engaged in development work at their property the greater part of the year. The main shaft was sunk to a depth of 155 feet. On this level drifts were driven northeast 126 feet and southwest 94 feet. On the 100-foot level, 100 feet of drifting and cross-cutting were done.

Mr. J. J. Backich, superintendent during the first part of the year, was succeeded by Mr. Dryden Smith.

Foulis Property

On Upper Manitou lake, about eight miles south of Gold Rock, Mr. J. C. Foulis was engaged during the latter part of the year prospecting a gold property. A shaft had been sunk about 40 feet. A 2-stamp mill was taken in just before the freeze-up in the fall of the year.

Minnehaha Gold Mine

At this property, owned by the Minnehaha Mining and Smelting Company, some mining work was carried on during the year. New camps were built and surface prospecting done during the summer.

Lake of the Woods District

There has been no marked revival of mining in this area during the year. The new owners of the Mikado gold mine have not yet begun active operations.

The Empire Gold Mining and Milling Company's property was not visited during the year. It is understood, however, that some work was carried on.

Sturgeon Lake Area

There was not as much mining activity at Sturgeon lake during 1909 as was anticipated. All the older properties were lying idle at the time of my inspection in the latter part of October. Access to the lake is very easy at present, being by way of the Grand Trunk Pacific railway from Fort William to Western Ontario Junction, then by way of the Western Ontario railway to the lake, a distance of seven miles. On the lake are several boats, most of them engaged in carrying freight for the National Transcontinental railway construction. The lake can be reached in about ten hours from Fort William.

At the St. Anthony mine there was some work performed during the year. New camp buildings were erected, but no mining was done.

At a claim three miles north of the St. Anthony, Mr. Wm. Leduit was engaged in sinking a shaft on a quartz vein. This shaft was, at the time of my visit, 48 feet deep. An 18-h.p. boiler and hoist were in use.

Vermilion (Northern) Pyrite Mine

This mine was inspected about the 1st of November, 1909. There is here a larger number of men employed, and greater activity, than at any other property west of Port Arthur. During the summer over 100 men were employed.

Mr. R. H. Craig is operating superintendent and Mr. R. C. Becker is manager.

An aerial tram has been built from the mine to the railway, about three miles distant, and about 7,000 tons of ore were shipped during the summer. The management of the mine purpose building a railway spur into the mine during the present year.

Underground the work has been carried on chiefly to prove the extent of the ore body, though during the summer there was considerable stoping done between the first and second levels east of No. 1 shaft, and on the south side of the vein. A raise was put through from the level below and by underhand stoping the ore was broken down into the raise and drawn off from the level below.

No. 2 shaft has been sunk to the first level and connected with No. 1 shaft by a drift about 400 feet in length. No. 2 shaft is a three-compartment shaft, sunk in the foot wall of the deposit and dipping at the same angle as the vein, which is 61 degrees to the horizontal. On the second level, from the cross-cut which has been driven across the deposit from No. 1 shaft, drifts have been run east 175 feet and west 50 feet. The ore is hard and fine-grained, and the shipments run from 45 to 48 per cent. sulphur.

A new rock house has been built near No. 2 shaft. The ore is trammed to this, passed through crushers and elevated to a trommel, which sizes it into (1) fines and (2)

ore that will pass through a $2\frac{1}{2}$-inch ring. These products pass into storage bins, from which the buckets on the aerial tram are loaded.

A new 100-h.p. boiler has been installed near the rock house for supplying power to the rock house engine.

Atikokan Iron Mine

Work was resumed in August, 1909, and about 150 tons per day were shipped during the time of operation. The work consisted of stoping on the wide ore body, about 50 feet from the mouth of the tunnel. A raise was put through west of the tunnel, and the ore mined by a system of underhand stoping to the raise. The stope is carried about 40 feet in width.

To the east of the tunnel the ore body has been reached by an open cut, the rock being stripped away down to the ore. Connection was then made with the drift on the ore body 100 feet west of the cross-cut.

The ore is trammed out of the tunnel and dumped into a large gyratory crusher, then elevated to a bin above the railway track, and loaded direct into cars.

Mr. F. Rodda was superintendent of the mine for the Atikokan Iron Company, employing a force of about 35 men.

Atikokan Blast Furnace

The Atikokan Iron Company started work again at their blast furnace in July, 1909. Mr. J. D. Fraser is manager. Ore from the company's mine at Atikokan, 132 miles west of Port Arthur, was used entirely. A full description of the plant was given in the Seventeenth Report of the Bureau of Mines.

Port Arthur Silver Mines

Some of the old silver mines along the Port Arthur and Duluth railway, which produced during their period of operation half a million dollars' worth of silver, were re-opened last year. Work was done on the Beaver, West Beaver, Climax, Porcupine and West End Silver Mountain mines.

Beaver Mine

This mine is about seven miles from Stanley Junction, 23 miles west of Port Arthur, on the Canadian Northern railway. An attempt was made to run the mill, which was erected in 1908. Some difficulty was experienced, and work ceased.

West Beaver Mine

The West Beaver is about one-half mile west of the Beaver mine, and was opened in 1909 by Mr. F. Keefer, of Port Arthur.

A shaft was sunk on a vein to a depth of 63 feet, and an adit was being driven into the hill on the strike of the vein to tap the shaft at a depth of 75 feet. Camps were built for the accommodation of the men at this property and at the Climax mine.

Capain Thos. Opie was in charge of the mining work.

Climax Mine

This property is situated due west and adjoining the West Beaver. It was being worked under option by Mr. B. E. Cartwright and associates during the latter part of 1909. An old shaft 55 feet deep has been unwatered, and a 15-h p. upright boiler and hoist installed.

Mr. Norman R. Fisher, of Cobalt, was consulting engineer, and Mr. Thos. Opie mine captain.

A shaft on the Porcupine has also been unwatered and a little work done.

West End Silver Mine

This mine has been worked at intervals for the last two or three years. At the time of my inspection, 19th November, 1909, work was being carried on, on the third and fourth levels of No. 2 shaft. The work consisted of drifting east on both levels, the third level, east drift, being now in 934 feet from the shaft, and the fourth level, east drift, 583 feet from the shaft. Both of these drifts are being driven on the vein.

Considerable work has been done on this property. Five shafts have been sunk; No. 5, the deepest, to a depth of 864 feet. No. 1 and No. 2 shafts are 536 feet apart, and are connected on the third level. The adit driven west to tap the third level of the mine is now in 575 feet, requiring 433 feet yet to be driven to connect.

The mill situated near the No. 2 shaft was run at intervals during the year. The property is being operated by the Hanson Consolidated Silver Mines, Limited, with Mr. W. T. Giles, secretary of the company, in charge at the mine.

Dominion Bessemer Ore Company

About 22 miles east of Port Arthur, at the head of Thunder bay, on lot C in the township of Macgregor, the Dominion Bessemer Ore Company, Limited, opened up an iron ore deposit in 1909, and shipped two cargoes of ore before the close of navigation. An ore-loading dock has been built, and a tramway from the dock to the ore body, about one mile inland. Half-way to the dock, at a convenient site, stock piles have been made. The ore will be loaded from these stock piles on tramcars and hauled to the dock, to be loaded directly into the boats. It is proposed to build ore pockets at the dock during the winter to facilitate the process of loading.

The ore lies in a bedded formation, varying in thickness from two to five feet. In mining it is separated into two grades, one grade running over 55 per cent. iron and the other below. Both grades carry a rather high percentage of manganese and no appreciable sulphur or phosphorus, and will thus be a desirable ore for furnace men.

Mr. S. G. Valentine is manager for the company. The contract for taking out the ore has been let to Mr. Arthur F. MacArthur, for whom Mr. F. W. Goodrich is in charge of the work.

II.—SUDBURY AND THE NORTH SHORE

In this area there was little change in 1909 so far as the working mines are concerned. The Canadian Copper Company and the Mond Nickel Company were the principal operators. The Dominion Nickel Copper Company were engaged chiefly in diamond drilling and building a spur from the Canadian Northern railway into the Whistle mine. The Bruce Mines is still the only copper property at work outside of the Sudbury district.

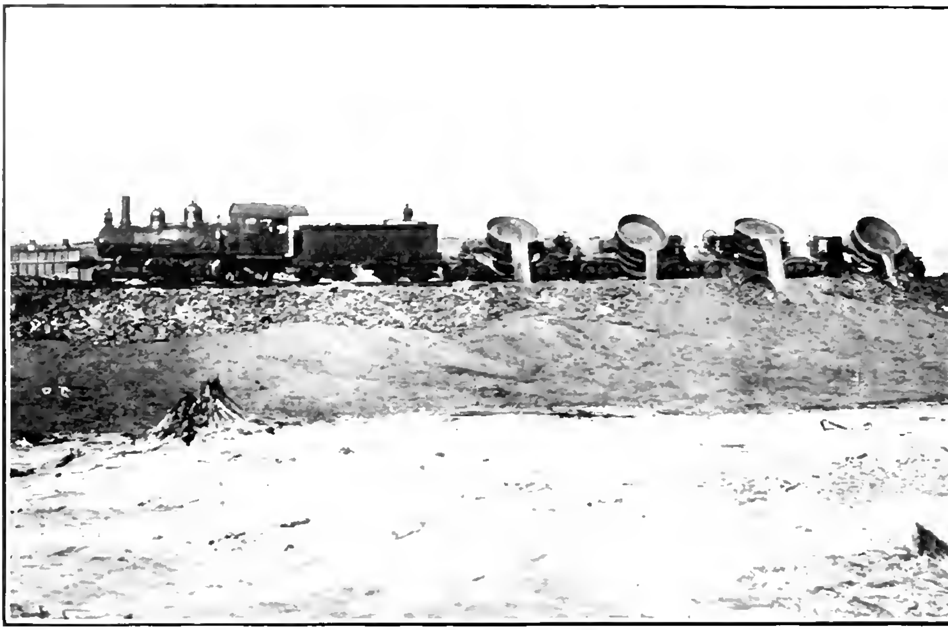
In the Michipicoten district the Helen iron mine continues to be the largest iron ore shipper in the Province. Other iron prospects were under development by the Lake Superior Corporation.

Shipments were made from the Moose Mountain iron mine, and preparations made during the past winter for a large output in 1910.

Gold

Havilah Mine

Work at this mine was carried on during the past year under manager S. H. Bryant. The old adit was cleaned out and timbered, and the shaft at the mouth of the adit cleaned out, timbered and sunk to the 100-foot level. The mine, formerly called the Ophir, is 18 miles north of Bruce Mines, in the township of Galbraith.



[illegible] Copper Company.

Underground, Creighton nickel mine.

Canadian Exploration Company

One mile south of Long lake, in township 69, and nine miles south of Naughton, the above company were steadily at work during the year. A 10-stamp mill with cyanide plant has been erected, and will be in operation in May, 1910. From the 75-foot level in the shaft about 400 feet of drifting has been done, with the view of exploring the ore body. It is intended to cyanide the ore direct without preliminary amalgamation, crushing it by stamps and tube mills.

Mr. R. W. Brigstocke is manager for the company.

Canadian Copper Company—(Nickel-Copper)

The Creighton and Crean Hill mines, owned and operated by the Canadian Copper Company, were heavy shippers during the year. A new quartz quarry was opened up in Dill township, alongside the Canadian Northern railway.

The officers of the company are: Mr. A. P. Turner, president and general manager; and Mr. John Lawson, general superintendent.

Creighton Mine

During the summer of 1909 work was carried on in the large open pit. Raises have the work was being carried on, on the second, fourth, fifth and sixth levels. During the breaking down tbe ore from the second to the third level by open pit work begun. The open pit is being carried down about the same size as on the second level. Both shafts are of the same depth as formerly described. In No. 1 shaft, fourth level, a drift has been run out about 150 feet to cut the ore body. No. 1 and No. 2 shafts are not yet connected on the fourth level. On the third level, No. 1 shaft, the ore is being drawn off from the open pit work. In No. 2 shaft, third level, the east end of the stope is being broken down as open pit. On the other parts of the ore body the filling system is in vogue, the ore being broken down by overhand stoping and the stope filled, the surplus ore being drawn off through chutes. On the fourth level, No. 2 shaft, all the ore is being broken down in this manner.

Power House and Rock House, Crean Hill nickel mine.

Crean Hill

During the year the shaft was sunk to the sixth level. At the last visit of inspection the work was being carried on, on the second, fourth, fifth and sixth levels. During the

summer part of the first level floor was broken down, making an open pit to the second level. The third and fourth level stopes have been worked in one stope for some time. The fourth and fifth levels were being worked by the filling system. Here the ore is sorted underground, and the stope filled with the waste rock, any surplus rock needed being let down from the surface through the raises. The area of the stopes has been enlarged during the year. On the sixth level the work was chiefly development work, consisting of driving a cross-cut from the shafts to and across the ore.

Quartz Quarry

The Canadian Copper Company last year opened up a quartz quarry in the township of Dill, on the main line of the Canadian Northern railway. About 300 tons of quartz are shipped daily to the smelter at Copper Cliff, where it is used as a flux and for converter linings. The quartz is being taken out by open pit work, derricks being used for hoisting.

Cobalt Refining Plant

This plant treated a large tonnage of high-grade ore shipped from the Cobalt mines during 1909, and was operated at its full capacity.

Nickel-Copper Smelter

There were no marked changes in the smelting plant during 1909. A description of the plant is given in the Seventeenth Report of the Bureau of Mines.

During the year the machine shop, car shop, foundry, warehouse, etc., near the general office, were torn down, new buildings having been erected near the smelter.

Roast Yards

The roast yards are now situated on the hill to the north of the town, between the town and the Manitoulin and North Shore railway. The roasted ore is loaded into drop-bottom cars by means of a steam shovel.

Mond Company—(Nickel-Copper)

The Mond Nickel Company are raising ore from the deepest level of any mine in the Province. They ship steadily now from the Victoria and Garson mines. Both mines use electric power, that for the former being obtained from the company's own plant at Wabageshik falls on the Vermilion river, and for the latter from the Wahnapitae Power Company, near Wahnapitae. A full description of these plants is given on another page of this report. The power for the smelter at Victoria mines is also obtained from Wabageshik falls.

Mr. C. V. Corliss is manager and Mr. O. Hall mine superintendent.

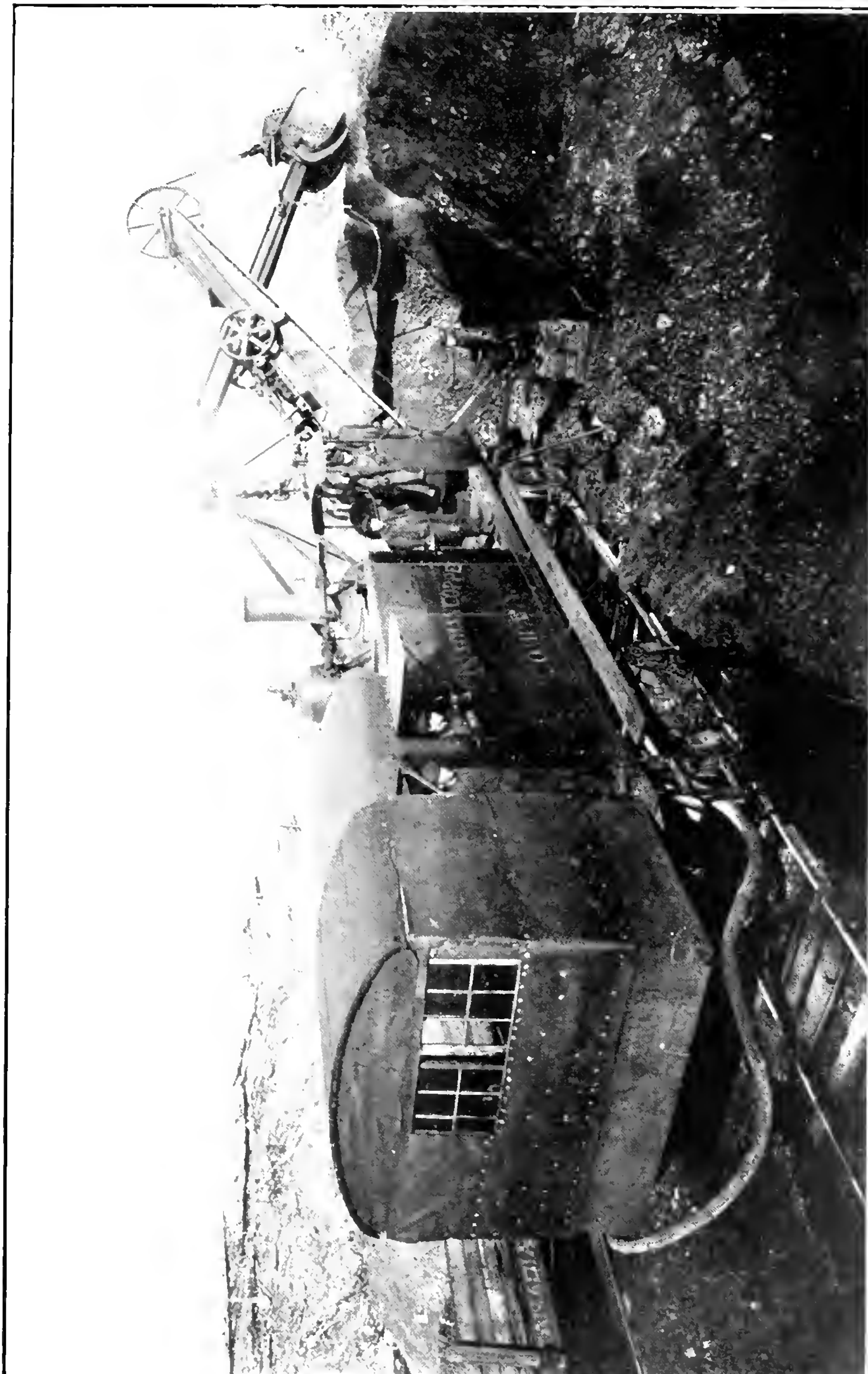
Victoria Mine

The main shaft is now down to the eleventh level. This is a depth of over 1,200 feet. The distance between the eighth and ninth and the ninth and tenth levels is 150 feet each, and between the tenth and eleventh 200 feet. The station has been cut at the eleventh level, and drifts started out to the ore body. Stoping is being carried on, on the eighth, ninth and tenth level stopes. On account of both ore bodies dipping to the east and the shaft being vertical, the distance to the ore on the lower levels is considerable.

Garson Mine

At this mine the shaft is now sunk to the 600-foot level. On the first and second levels stoping has been begun on the several ore bodies. On the third fourth and fifth levels sections are being cut the full size of the ore body. On the sixth level the shaft station has been cut and cross-cut driven to the ore bodies.

The power house has been enlarged and a new air compressor, belt driven by motor, installed. This necessitated the installing of additional transformers.



Loading roasted ore with steam shovel, Canadian Copper Company.

Smelter

The smelter at Victoria mines was remodelled in 1908 and the capacity increased It has been run continuously since that time on ore from the company's two mines.

Roast Yards

The roast yards are located on the line of the aerial tram about half-way between the smelter and Victoria mine. The green ore is brought from the mine to the roast yards by the aerial tram buckets which are then loaded with roasted ore and carried to the smelter. The green ore from the Garson mine is brought by train to the smelter, where it is loaded into the buckets on the aerial tram and taken out to the roast yards.

Quartz Quarry

The company obtain the quartz for flux and re-lining converters from a quarry about a quarter of a mile north of the smelter.

Moose Mountain iron mine.

Dominion Nickel Company—(Nickel Copper)

The Dominion Nickel Company were engaged during the year chiefly in diamond drilling and sinking a shaft at the Whistle mine. They were also constructing a spur line from the Canadian Northern railway to the property.

Copper

Bruce Mines

This mine was worked continuously during 1909 by The Bruce Mines, Limited. The concentrating mill has not been operated as yet by the present owners. Work in the mine has been carried on chiefly on the fourth level of No. 4 shaft, where some stoping has been done, and on the fifth level of No. 2 shaft, where drifts have been run east and west, a distance of 400 feet and 200 feet respectively. Some stoping was also done on the third level west of No. 4 shaft between Nos. 2 and 3 dikes. Most of the ore taken out is being stock-piled. A winze was sunk to a depth of 95 feet on the fourth level 500 feet west of No. 4 shaft. Some shipments were made during the year to the Mond Nickel Company.

Hermina Mine

Operations ceased during the summer of 1909. The work done since the last Report consisted in sinking the shaft to the 500-foot level and driving a cross-cut to cut the ore body.

Iron

Moose Mountain Mine

The Moose Mountain iron mine shipped steadily during the latter part of 1909. The ore was taken out of No. 1 deposit by underhand stoping from a face about 65 feet in height. It was then crushed to an inch product and passed over a magnetic cobber to sort out the waste rock. During the winter a large plant has been put in for magnetic concentration of the ore. The ore is trammed from the open pit and dumped into a large pocket, from which it is fed into crushers, which reduce it to a uniform size under 1 inch. It is then taken by incline belt conveyor to the magnetic concentrators about 300 feet south. Here it is dumped into bins, from which it is fed to the magnetic separator. It is then trammed about 100 feet and dumped into the railway cars. No ore is shipped during the winter months.

Mr. F. Jordan is manager.

Michipicoten Harbor, showing ore train from Helen mine.

Ore Docks at Key Inlet

The ore from Moose Mountain mine is hauled by the Canadian Northern railway a distance of 80 miles to the docks at Key Inlet. Here the ore is dumped from the hopper-bottom cars into bins. These bins are arranged so that they will feed from the centre of the bottom to a 42-inch travelling belt, which conveys the ore to a similar belt on the docks, and which in turn conveys and elevates the ore to the dock trestle, 60 feet above the water level. The ore is weighed by an automatic device while on the belt. When it reaches the dock trestle it is tripped off and dumped into pockets, from which it is spouted into the holds of the vessels alongside the dock. It is expected that 800 tons of ore per hour can be loaded. The pockets have a capacity of about 8,000 tons. The belts are driven by motors.

Michipicoten Area

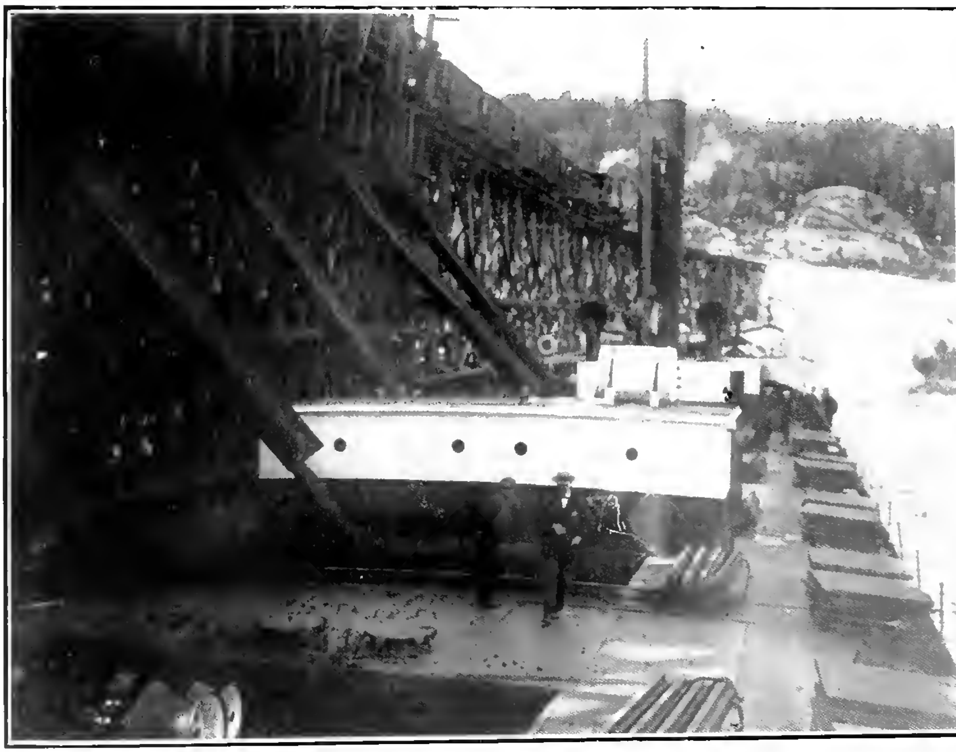
Helen Iron Mine

The Lake Superior Power Company, owners of the Helen iron mine, shipped about 1,000 tons of ore per day during the season of navigation in 1909. No. 1 shaft is now down to the sixth level, a depth of 450 feet. This level is being opened up during the winter in a way similar to the fourth and fifth, with the view of shipping ore during 1910. Last year most of the ore was hoisted from the fifth level.

A drift was run north on the third level from No. 1 stope through the dike, a distance of 70 feet, and encountered a good grade of bessemer ore. The extent of the body was not proved at the time of my inspection.

A drift has also been driven south-east from the easterly limit of the iron ore, on the fifth level, a distance of 80 feet, where a body of iron pyrites was encountered. A considerable tonnage of iron pyrites has been blocked out. Next summer both iron ore and iron pyrites will be shipped. During the winter the ore taken out in development work was hoisted to the fourth level and dumped in the old stope, from which it will be drawn off when shipments begin.

The surface plant has been electrified throughout, electric power having been obtained from the Algoma Power Company at High Falls on the Michipicoten river. A new 12-drill compressor driven by a 200 horse-power motor has been installed, together with the following: An 80 horse-power motor to drive the crusher, 80 horse-power motor to drive No. 1 hoist, and a 150 horse-power motor to drive No. 2 hoist.



Loading Helen Mine ore at Michipicoten.

A new turbine pump driven by a 100 horse-power motor with a capacity of 500 gallons per minute against a 400-foot head has been installed on the fifth level. The power is brought from the power house at High Falls at 10,000 volts and stepped down at the transformer house at the mine to 550 volts. The steam plant is kept in reserve in case there is a break-down on the line or at the power plant.

Mr. A. A. Alsip is mine superintendent.

The company have also been developing an iron property called the Magpie, about 15 miles northeast of the Helen, and near the located route of the Algoma Central railway from Michipicoten to the main line of the Canadian Pacific. Construction work is now in progress on the railway from the Helen to the Magpie.

Other work is being done by the company at Iron lake south of White river, and at Goudreau lake.

Norwalk Gold Mine

This mine was originally known as the Manxman. It was in operation during most of 1909.

The shaft is now at a depth of 210 feet with levels at 100 feet and 200 feet. On the first level drifts have been driven north and south 25 feet respectively, and on the second level 75 feet south and 20 feet north. The shaft is on an incline of 30 degrees.

The old 10-stamp mill is being remodelled and a 25 horse-power motor installed to drive it. There is a 50 horse-power motor at the mine to operate the compressor. Power is obtained from the Algoma Power Company.

Mr. Samnel Moore is manager.

Kitchegammi Gold Mine

The Braddock Development Company took over the old Kitchegammi property about three-quarters of a mile from High Falls and started work at it in the spring of 1909. A mill was erected and two Nissen stamps installed, driven by a 75 horse-power motor,

Kitchegammi stamp mill, Michipicoten.

which also drives a 3-drill Fairbanks compressor. The shaft, which is said to be 100 feet deep, was not unwatered.

Mr. J. M. Herancame is superintendent.

The Grace mine, owned by the Le Page Gold Mining Company, was not in operation during the year.

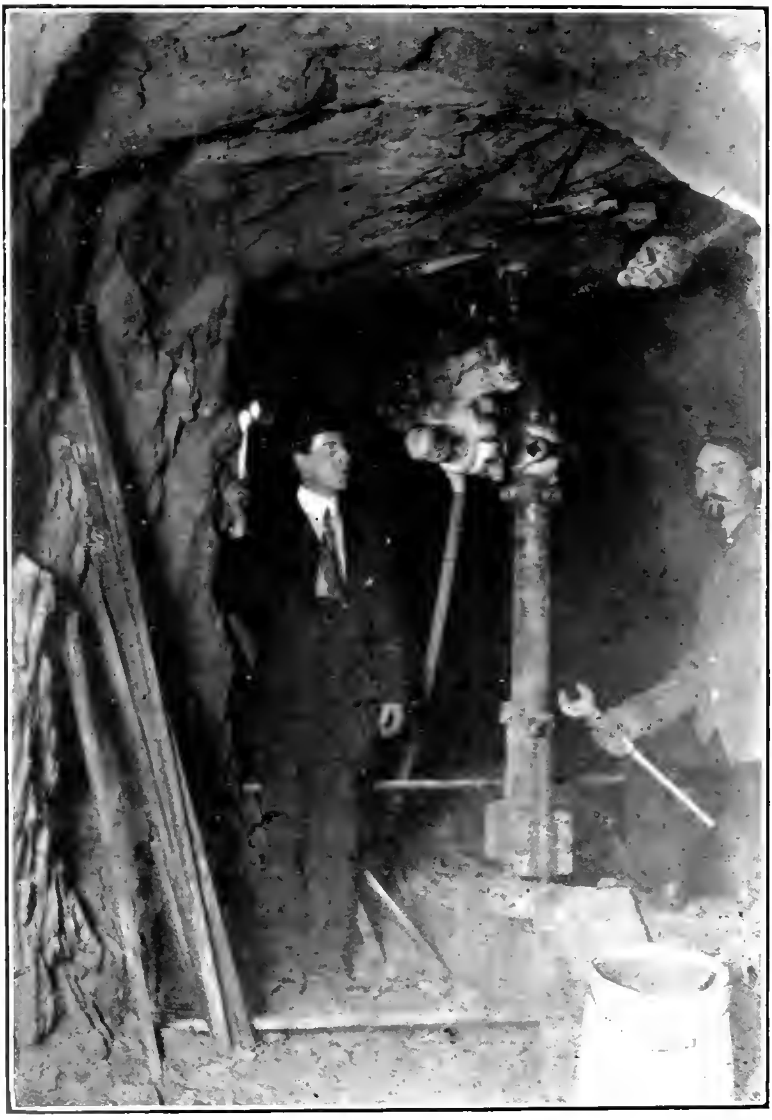
Some prospecting was done on the claims owned by the Golden Reed Mining Company.

III.—TEMISKAMING

Cobalt and Vicinity

Cobalt's production of silver in 1909 exceeded that of any previous year, the total yield being about 26,000,000 ounces, compared with 19,437,875 ounces in 1908. The increased output required larger working forces at the mines, and consequently a larger amount was paid in wages for labor, the rate of wages being the same as in 1908. After the sale of the Gillies Limit lots in 1909, a considerable number of men were employed there, which increased the total of the number of men at work in the camp.

None of the companies who were developing water power were able to supply power during 1909. The incoming year will see the Cobalt Hydraulic Power Company, the Mines Power, Limited, and the Cobalt Power Company delivering power to the camp. The first company will supply compressed air, the second company both compressed air and electric power, and the third company electric power only. A number of small pro-



Underground view, Cobalt.

perties are shut down until the power reaches the camp. Some of the concentrating mills are unable to run to their full capacity owing to the lack of power. A full description of these three power plants will be found on another page of this Report.

As stated in a former Report, the concentration of ore at Cobalt has become very closely associated with the economic working of the mines.

On April 16th, 1910, mills were in operation at the following mines:—Buffalo, Cobalt Central, Colonial, Coniagas, King Edward, McKinley-Darragh, O'Brien, Silver Cliff, Temiskaming; the Ore Reduction Company and the Northern Customs Concentrator were also operating custom plants.

These 11 mills have a capacity of from 850 to 1,000 tons per 24 hours. The Coniagas, McKinley-Darragh and the Northern Customs have increased their capacity by the addition of 30 stamps, 10 stamps and 22 stamps respectively, which will increase the camp tonnage to 1,000 or 1,150 tons.

The Nova Scotia and the Trethewey mills are under construction and together will handle when completed about 175 tons per day. This will give a total concentrating capacity of 1,150 to 1,300 tons of ore per 24 hours. A small tonnage of concentrating ore was shipped during last year to the Montreal Reduction and Smelting Company at Trout Mills.

Northern customs Concentrator, cobalt.

South Lorrain

During the winter South Lorrain has come into prominence through the shipments of four carloads of ore from the Wettlaufer mine. Other silver discoveries were made, and as a result considerable mining work was done during the winter on a number of properties. The power line of the Mines Power, Limited, passes practically through the camp, so that electric power can be obtained without any difficulty. This company purposes installing a transformer station at Beaver lake and Latour lake to furnish power for the camp.

Montreal River

Although considerable mining and prospecting work has been going on in this area, only one carload of ore was shipped during the winter. This was from the Lucky Godfrey claim. The towns of Elk Lake and Smyth on opposite sides of the Montreal river were each visited by fire during the winter and considerable damage inflicted. These places form the distributing centre for the Montreal river area and are on the road to Gowganda.

Gowganda

The properties east and west of Gowganda lake shipped during the winter 292.8 tons of ore. The largest shipper was the Millerett Mining Company near Miller lake, east of Gowganda. The boom of one year ago injured the camp, but a number of properties are doing considerable development work. The high prices of supplies during 1909 enhanced the cost of mining. The Government road from Elk Lake to Gowganda was completed late in the fall of the year. This reduced the cost of haulage, the average freight rate on foodstuffs from Charlton to Gowganda during the winter being 1½ cents a pound. Access to the camp during the summer will also be quite easy by way of the Montreal river and the Government road to Gowganda.

Porcupine

In September, 1909, news of rich discoveries of gold in the townships of Whitney and Tisdale began to be reported. This occasioned a rush of claim-stakers into the district, and a few thousand claims were staked on the prospect of a big boom, which

Millerett Mine, Gowganda.

would give saleable value to anything staked out. The expected boom failed to arrive, although some of the better-known properties were taken over at fairly large figures. A few plants were rushed into the camp late in the spring of 1910. Some of the properties are in the hands of companies who will thoroughly test them during the next year.

A winter road was cut into Porcupine lake from Mileage 222 on the T. & N.O. railway. The route followed in the fall of 1908 was from Mileage 228 over a half mile portage to a small stream leading into Frederick House lake, then by way of the Frederick House river, Night Hawk lake and Porcupine river. Access in summer can be had by the above route or by way of the Mattagami river from the Transcontinental crossing south about 45 miles. This river runs within a mile and a half of the Hollinger claims.

Larder Lake

Very little mining work was done at Larder lake in 1909. Most of the work done consisted of assessment work to fulfil the requirements of the Mining Act.

Cobalt Silver Mines

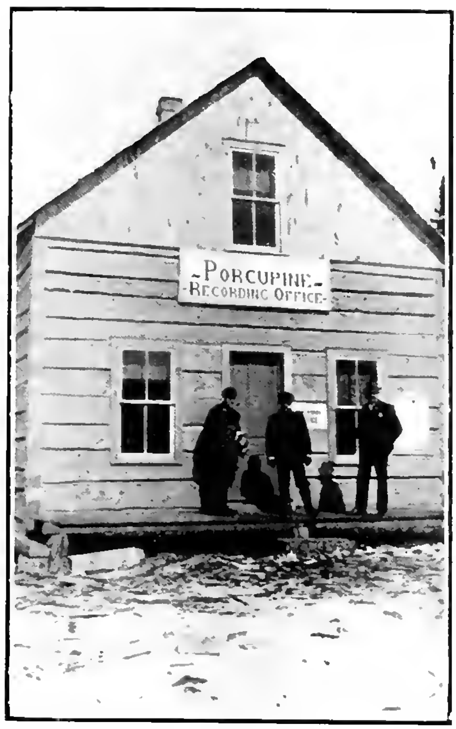
The following is a brief description of the principal mines and prospects of the Cobalt camp arranged alphabetically, followed by a description of the properties in South Lorrain camp, Montreal river, Gowganda and Porcupine. The amount of production and dividends paid will be found on preceding pages of the Report.

Alexandra

The Alexandra Mining Company are operating on the north part of the south-east quarter of the north half of lot 5 in the fourth concession of Coleman.

A shaft has been sunk 300 feet in depth and drifting started at this level. The shaft has passed through the diabase sill, into the conglomerate.

A 40 horse-power locomotive firing boiler and hoist are in use.



Porcupine Recording Office.

Argentite

This property is worked under lease from the Argentite Mining and Smelting Company, Limited, by Mr. W. J. White of New York. Considerable underground development work was done during the year.

Argentum

The Argentum Mines, Limited, have acquired a five years' lease of the Foster mine and also of the south-east quarter of the north half of lot 2 in the fourth concession of Coleman. The chief work on the latter location has been trenching and test pitting.

The workings of the Foster mine will be taken up under that heading.

Badger

Work at the Badger mine was continued uninterruptedly during 1909. The main work was carried on from No. 9 shaft. On the 100-foot level drifts have been run east and west 80 feet and 260 feet. This level is also connected by a raise with No. 1 shaft, which is 60 feet deep and has about 100 feet of drifting at that level. On the 200-foot level of No. 9 shaft drifts have been run east 180 feet and west 120 feet, from which point a drift has been driven south 125 feet, and about 120 feet of drifting done here under No. 7 shaft. East of the shaft 110 feet, a raise has been put through to the first level. No. 5 shaft, about 550 feet east of No. 6, has been sunk to a depth of 140 feet, and a drift driven south-west 289 feet.

Mr. A. A. Smith is manager.

Badger mine, Cobalt.

Bailey

The Bailey Cobalt Mines, Limited, on the termination of the lease to the Standard Cobalt Mines, Limited, on April 1st, 1909, commenced development, and have been operating since that time. About 600 feet of drifting has been done from the several shafts, in addition to that described in the last Report, which was done by the Standard Cobalt Mines, Limited.

Beaver

This property is owned by the Beaver Consolidated Mines, Limited, and began shipping ore in the latter part of 1909.

Ore was encountered in a 100-foot winze from a drift on a vein on the 200-foot level. On the second level, cross-cuts have been driven east and west, a distance of 310 and 320 feet respectively. The first vein was struck 60 feet east of the shaft, and on this a drift was run north 410 feet. At 210 feet north of cross-cut on this vein, a winze was sunk 100 feet, and 100 feet of drifting done at this level. The ore was found in this winze. On a vein 220 feet east of the shaft 400 feet of drifting has been done, and on a vein 230 feet west of the shaft, 240 feet of drifting.

The main shaft has recently been re-timbered, a new head frame and ore house erected, a new hoist installed and camp buildings erected.

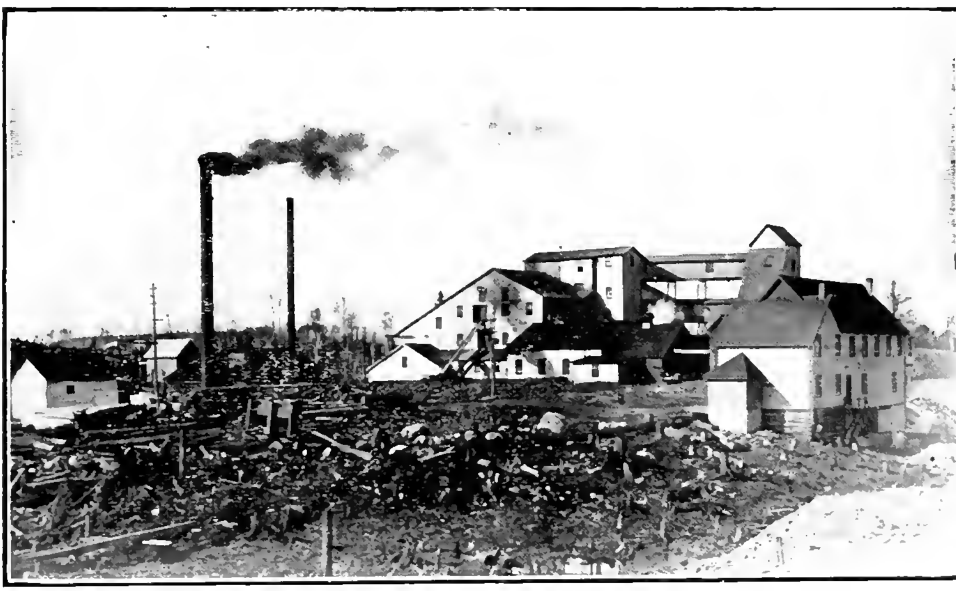
Mr. A. J. Hewitt is superintendent.

Belmont

The Belmont Silver Mines of Kerr Lake, Limited, own the north-east part of lot 2 in the fourth concession of Coleman. Work has been in progress for the last year under Mr. L. Brown. A shaft has been sunk to a depth of 80 feet and considerable surface trenching done. Power was obtained from the Silver Cross mine.

Buffalo

The main part of the development work at the Buffalo mine was confined to the southern portion of the claim. No. 12 shaft was sunk to the third level, and 1,000 feet of drifting done on this level, opening up some good ore bodies. On the other



Buffalo concentrator, Cobalt.

levels the mining work consisted chiefly of putting in timbers preparatory to stoping and in breaking down ore in the stopes. All the ore is trammed underground to No. 6 shaft, where it is hoisted to the mill.

The mill has been slightly remodelled and a cyanide plant added, which has neen in operation for several months. The scheme of concentration is not greatly altered, being as follows:—Ore is passed through crusher, then to No. 1 rolls, and through trommel. Then the different sizes go to jigs. The coarse jig tailings pass through other sets of rolls, and the coarser product goes to classifiers and to Wilfley and James tables. The middlings from the tailings, and the fine product from the jigs, pass through a Chilian mill, then to classifier, the overflow going direct to the cyanide tanks and the sands to four Deister tables. The middlings from these tables are sent back to the Chilian mill.

Mr. Tom R. Jones is general superintendent.

Canuck

The Canuck Silver Mines Cobalt, Limited, own the southeast quarter of the south half of lot 13, in the first concession of Bucke.

The shaft is 150 feet deep, and about 30 feet of drifting have been done. There is a 12-h.p. upright boiler and hoist.

Casey Cobalt

This property, situated on the southeast quarter of the south half of lot 5, in the first concession of Casey, and owned by the Casey Cobalt Mining Company, was not in operation the first part of the year. After beginning work again some good ore was encountered on the 220-foot level of the mine. On this level 200 feet of drifting and cross-cutting have been done and some stoping.

Mr. James Rennie, former manager of the mine, has been succeeded by Mr. James Hoskin.

Century

This location, owned by the Century Silver Mining Company, Limited, with head office in Toronto, is situated on the east half of the northeast quarter of the north half of lot 1, in the sixth concession of Coleman.

The shaft has been sunk to a depth of 175 feet, and about 300 feet of drifting and cross-cutting done, also considerable trenching.

Chambers-Ferland

The Chambers-Ferland Mining Company have been working chiefly in No. 1 shaft, on a vein which is the continuation of No. 10 vein on La Rose. This shaft is 100 feet deep, with levels at 42 feet and 93 feet. The distance of the vein between La Rose and O'Brien lines is about 180 feet. Above the first level considerable stoping has been done.

Work at No. 2 shaft ceased in May, 1909. The shaft was sunk about 100 feet, and about 900 feet of drifting and cross-cutting done on this level.

Mr. C. Watson is manager.

City of Cobalt

The City of Cobalt Mining Company, Limited, have been mining steadily during 1909. The main shaft remains at the same depth, but a winze has been sunk west of the shaft to a depth of 65 feet, from which level about 700 feet of drifting has been done. A cross-cut has been driven north and east from the shaft a distance of 1,000 feet. A good deal of stoping has been done between the first and third levels, both east and west of the shaft. A considerable tonnage of milling ore has been developed, and the company have constructed a tramway from their shaft to the Northern Customs Concentrator for tramming the ore to the mill for treatment.

Mr. A. S. Stevens is superintendent.

Cleopatra

The Cleopatra Mining Company took over from Mr. Bannell Sawyer lots A.24, A.25 and A.38 on the Gillies Limit, purchased by him from the Ontario Government. Considerable surface work, such as trenching, was done during the latter part of 1909. A shaft is being sunk, the present depth being 100 feet.

Cobalt Central

The Standard Cobalt Mines sank a shaft to a depth of about 50 feet on the Gamey location last year.

The Cobalt Central mine was continuously in operation, and the shaft was sunk to the fifth level, a depth of about 330 feet. The fourth level, at a depth of 255 feet, is all in slate, this formation having been encountered at a depth of 230 feet. Considerable ore was stoped from this level, and about 800 feet of drifting done. On the fifth level a drift has been driven from the shaft 100 feet.

The concentrating mill was run steadily throughout the year, treating from 80 to 100 tons of ore per day.

Cobalt Gem

The Cobalt Gem Mining Company, Limited, own the east half of the southwest quarter of the south half of lot 3 in the fourth concession of Coleman. The principal work done during the summer was trenching. The large nugget of float bought by the Ontario Government, a description of which is given on a previous page, was found on this claim. Some test pitting has also been done.

Cobalt Lake

The mining work done by the Cobalt Lake Mining Company during the last year was confined to No. 6 shaft at the south end of the lake. The level at 130 feet has been run west along the McKinley-Darragh boundary, a distance of 500 feet. A winze was sunk here to a depth of 50 feet, and 250 feet of drifting done on the vein on this level. A cross-cut was here driven west, and another vein was encountered parallel to the first. On this vein 100 feet of drifting has been done. The winze is being sunk another 50 feet. Not much stoping has yet been done on the veins.

The work of running a drift from No. 1 shaft across the lake was completed in 1909. The drift is about 400 feet in length.

Mr. A. P. Seymour is manager.

Cobalt Merger

A controlling interest in the Cobalt Merger, Limited, was purchased in September, 1909, by the Right of Way Mining Company, and some work, consisting chiefly of trenching, was done on the claims during the latter part of the year.

Cobalt Paymaster

The Cobalt Paymaster Mines, Limited, have taken a lease of the northeast quarter of the north half of lot 6, in the sixth concession of Coleman, and were engaged in work on it during 1909. The shaft is sunk to a depth of 115 feet, and a cross-cut has been run north about 250 feet. On two of the veins which were struck some drifting was done. The company have had a diamond drill at work on the property for some time. The surface plant consists of a 50-h.p. boiler, 4-drill compressor and hoist.

Mr. M. B. Gordon is manager.

Cobalt Silver Queen

The only work that is being done on this property now, is sinking the main shaft. This is being put down from the 150-foot level to the 400-foot level. It is now at a depth of 275 feet. The ore has been mostly stoped out of No. 1 vein.

Another shaft, 500 feet south of No. 1 shaft, was sunk during 1909 to a depth of 86 feet. From this shaft 300 feet of drifting was done. Other prospect shafts have been sunk on the property, and a considerable amount of drifting done.

Mr. Robt. A. Bryce is superintendent.

Cobalt Station Grounds

The Cobalt Station Grounds Mining Company, Limited, acquired a lease of two parcels of ground from the Temiskaming and Northern Ontario Railway Commission. One parcel is the mining rights extending under the right of way just south of the Right of Way Mining Company's shaft at the north to near the Silver Queen property, including the station grounds. The other parcel consists of two town lots, Nos. 388 and 389. The work of prospecting these lots began in the fall of 1908, consisting of trenching, diamond drilling and shaft sinking. No. 4 shaft of the Cobalt Lake Mining Company was taken over for a time, and some drifting and cross-cutting done from their workings, which had been extended west to the railway right of way. After work ceased here a shaft was sunk near the railway cut south of the station. This shaft was sunk to a depth of 140 feet.

Mr. T. A. Beament, of Ottawa, is president of the company, and Mr. J. B. Watson secretary-treasurer.

Cobalt Town Site

The Cobalt Town Site Mining Company, Limited, resumed operations during 1909. The main work being done is driving a cross-cut from the main shaft south to cut a vein on which the Right of Way Mining Company are working. This cross-cut has been driven about 300 feet.

Cochrane Cobalt

The Cochrane Cobalt Mining Company, Limited, have done considerable work on the east half of the southwest quarter of the north half of lot 1, in the third concession of Coleman.

A shaft has been sunk to a depth of 230 feet. On the 100-foot level a cross-cut has been driven 15 feet. On the 200-foot level the cross-cut west is 79 feet in length and east 160 feet. The east vein is 84 feet from the shaft, and a drift has been run south on this vein 106 feet. The west vein is 48 feet from the shaft, and has 14 feet of drifting on it.

A plant, consisting of a 60-h.p. boiler, 4-drill compressor and hoist, has been installed.

Sir Henry Pellatt is president of the company, and Mr. J. W. Shaw is mine superintendent.

Colonial

The Colonial Silver Mines resumed mining operations in Oct., 1909, after having been suspended for about a year. Work is being carried on from the adit about 100 feet from the mill. This adit has been driven southeast about 400 feet. At 240 feet from the mouth of the adit a shaft has been run on a vein, west 250 feet. From this drift a winze has been sunk 75 feet, and a raise put through to another adit level, about 30 feet above. On a vein on this level some stoping is being done. A hoist has been put underground on the main adit level, and the ore will be hoisted to this level, and thence trammed to the mill. The old workings consist of an adit 500 feet east of the present working adit. Here there are some 1,000 feet of drifting and cross-cutting. On the adit south of the office about 1,000 feet of work has also been done.

The 10-stamp mill was completed last year. The ore is trammed from the adit and dumped into the crusher, from which it passes into rolls and over trommels, the fine product going direct to the classifier, while the coarse product goes to a Hartz jig. The tailings from the jig go to the 10-stamp mill, and thence to a classifier. The several products from the classifier are led to a Wilfley table, Deister table and Deister slimer. A tube mill is being put in to re-crush the tailings from the sand tables.

Electric power is used throughout the mill, the power being obtained from the Cobalt Power Company.

Mr. C. B. Kingsley is manager.

Columbus

No work was going on at this property during the latter part of 1909. The work done, in addition to that described in the last Report, consisted chiefly of driving a cross-cut from the 240-foot level east, a distance of 150 feet, and some drifting.

Coniagas

The mine and mill of the Coniagas Mines, Limited, were operated continuously during 1909. According to the superintendent's report 51 feet of shaft sinking, 1,254 feet of drifting, 376 feet of cross-cutting and 80 feet of winzing were done during the year, in addition to obtaining 19,472 tons of ore by stoping.

Most of the development work underground was done on the 150-foot level. A winze was sunk about 170 feet southeast of No. 2 shaft a depth of 75 feet. A drift was driven from this to No. 2 shaft and a raise put through. The third level of No. 2 shaft is, therefore, at a depth of 225 feet.

No. 4 shaft, near the south end of the property, was sunk to a depth of 55 feet.

About 70 tons per day were treated in the mill. Thirty stamps were added in the latter part of 1909, with tables to handle the product. This addition is ready to operate when the electric power being developed on the Montreal river and on the Matabitchouan river is supplied, and will raise the tonnage the mill is capable of handling to 150 or 160 tons per 24 hours.

Coniagas Reduction Company

The Coniagas Mines, Limited, own the capital stock of the Coniagas Reduction Company. The reduction plant is located at Thorold, and during 1909 treated the entire product of the Coniagas mine and 315 tons of ore purchased from other mines. The company have during the year put up further extensions to refine not only the silver and arsenic, but also the nickel and cobalt, which have been stocked up to the present.

Coniagas shaft house and concentrator.

Consolidated Silver (Green-Meehan)

The Consolidated Silver Cobalt Mines, Limited, took over the Green-Meehan and Red Rock mines. Considerable trenching was done on the properties during 1909. The mining work on the Green-Meehan to date consists of sinking two shafts 110 feet and 85 feet. On the 100-foot level drifts have been driven north 200 feet and south 225 feet, and 175 feet of cross-cutting done. An open cut was run on the vein, on which the main shaft was sunk, for a length of 250 feet.

On the Red Rock no work has been done for about two years. Prior to this three shafts had been sunk to a depth of 35, 75 and 110 feet respectively. On the 100-foot level of the deeper shaft about 200 feet of drifting was done.

On the Green-Meehan a plant was installed, consisting of two 100-h.p. boilers, 12-drill compressor and hoist.

Mr. Howard Chapin is mine superintendent.

Cross Lake

The Cross Lake Silver Mining Company, of which Mr. Carl Reinhart is president and manager, have been working on the southwest part of the southwest quarter of the south half of lot 1, in the fifth concession of Coleman. The work has consisted chiefly of trenching, and of sinking a shaft to a depth of 50 feet by hand.

Crown Reserve

The Crown Reserve Mining Company have, since July, 1908, paid over one and a half million dollars in dividends. The development of the property has been carried on very energetically during that time. No. 1 and No. 2 shafts are both sunk to a depth of 200 feet, and a winze at the east end of the Carson vein has been sunk another 100 feet. On the first level a cross-cut has been driven north, a distance of 480 feet and east 520 feet. There has also been considerable drifting on the veins encountered. Altogether, on the first level there has been about 2,500 feet of drifting and cross-cutting. On the second level a drift has been run on the Carson vein for a distance of about 250 feet. Cross-cuts have been driven north 300 feet and east 450 feet. Some stoping has been done on the Carson vein on the second level. Stoping has been carried on, on this and the north veins on the first level.

A larger plant was installed, consisting of a 12-drill compressor, another 100-h.p. boiler, and a larger hoist.

Crysler-Niles

The Crysler-Niles Mining Company, Limited, own the northeast quarter of the south half, and the southeast quarter of the north half, of lot 2 in the tenth concession of Lorrain.

The main shaft has been sunk to a depth of 200 feet, and a great deal of trenching done on the surface.

The plant consists of a 60-h.p. boiler and a 4-drill compressor and hoist.

No work was being done at the property in February, 1910.

Dreadnought

The Dreadnought Mines, Limited, took over the holdings of the Rothschild Mining Company, consisting of the northwest quarter of the north half of lot 3, in the third concession of Coleman.

Considerable trenching had been done and two shafts sunk by the former owners. These shafts were 75 feet and 100 feet deep respectively, and there was some drifting and cross-cutting at one of the levels.

A 60-h.p. boiler and a 4-drill compressor and hoist were installed by the old company.

Drummond

During 1909 the underground work at the Drummond mine consisted chiefly in cross-cutting north from the 200-foot level of the main shaft under Kerr lake. This cross-cut has been driven about 400 feet. During the year considerable trenching and diamond drilling were done on the property. A large amount of the milling rock on the dump was shipped to Trout Mills for concentration.

Mr. R. W. Brigstocke is manager.

Eastbourne

The Eastbourne Cobalt Mines, Limited, have been operating on the north half of the northeast quarter of the south half of lot 2, in the fourth concession of Coleman. A shaft has been sunk to a depth of 100 feet, in addition to considerable trenching and surface work.

Empire

The Empire Cobalt Mines, Limited, have a number of properties in Lorrain and Coleman. On lot 2, in the tenth concession of Lorrain, a shaft has been sunk to a depth of 125 feet, and some drifting done.

A small plant, consisting of boiler, compressor and hoist, has been installed.

E. T. Property

The E. T. Mining Company have acquired the north half of the northwest quarter of the north half of lot 1, in the fourth concession of Coleman, and have been working on it during 1909. Some trenching was done, and a shaft sunk to a depth of 100 feet.

Mr. L. Brown is consulting engineer for the company.

Farah

The Farah Mining Company have been working continuously during the year. No. 1 shaft is 150 feet deep and has a drift north 200 feet. No. 3 shaft is 150 feet deep, with the first level at 75 feet. Drifts have been driven north on the first level 140 feet, and on the second level 100 feet. No. 5 shaft is 50 feet deep, with some drifting at this level.

Foster

The Foster Cobalt Mining Company, Limited, decided in April, 1909, to lease the Foster mine to the Argentum Mines, Limited, for a term of five years. Under the agreement the Argentum Company are to expend $25,000 during the first year, and to work continuously for the balance of the term, and to pay the Foster Cobalt Mining Company 50 per cent. of the net profit each year up to $100,000.

The Argentum Mines have carried on work continuously since April under Superintendent J. MacDonald, both above and below ground. Considerable diamond drilling was also done on the property during 1909.

Gifford

The Gifford Cobalt Mines, Limited, have been developing the north half of the northeast quarter of the north half of lot 1, in the third concession of Coleman.

A shaft has been sunk 200 feet, and 150 feet of drifting and cross-cutting done.

The plant consists of a small boiler and hoist. Air for drilling is obtained from the Temiskaming mine.

Mr. Chas. Gifford, Toronto, is president of the company.

Gifford Extension

The Gifford Extension Mines, Limited, control the southwest quarter of the south half of lot 1, in the third concession, and the north half of the east half of the southwest quarter of lot 2, in the third concession, both in Coleman.

A number of test shafts have been sunk on the property and considerable trenching done. A shaft has been put down a depth of 200 feet, and about 75 feet of drifting done, on the lot adjoining the Ophir.

Goodwin Lake

The Goodwin Lake Mines, Limited, have five 40-acre claims on lots 3 and 4, in the eighth concession of Lorrain.

A shaft has been sunk to a depth of 100 feet, and considerable prospecting done on the surface.

Mr. Wm. Cuthbert, of Montreal, is president of the company.

Gould Consolidated

The Gould Consolidated Mines, Limited, are working a lease from the Peterson Lake Silver Mining Company on Cart lake.

Two shafts have been sunk, one 60 feet and the other 150 feet. In the deeper shaft about 60 feet of drifting has been done on the 75-foot level, and 60 feet on the 150-foot level.

Hargrave

The Hargrave Silver Mines, Limited, were actively engaged last year in mining operations on the southwest quarter of the north half of lot 2, in the fourth concession, and the northwest quarter of the south half of lot 3, in the fourth concession of Coleman. No. 3 shaft was sunk to a depth of 375 feet. On this level a drift was run north 160 feet, and from here a cross-cut was driven west 50 feet, and 150 feet of drifting done north and south on the vein cut by this cross-cut. On the 175-foot level drifts have been run south 150 feet and north 135 feet, also a cross-cut of 65 feet. On No. 1 shaft, on the north end of the east lot, a shaft has been sunk to a depth of 75 feet, and about 40 feet of drifting done.

Mr. E. V. Neelands is mine superintendent.

Imperial Crown

The Imperial Crown Mines, Limited, of which Colonel John Carson, of Montreal, is president, acquired the west half of the southeast quarter of the south half of lot 3, in the fifth concession of Coleman, and have been engaged prospecting it during 1909. A great deal of trenching was done, and one shaft was sunk to a depth of 100 feet, with 100 feet of drifting at this level.

Power was obtained from the Crown Reserve Mining Company.

John Black

The John Black mine comprises the west half of the north-west quarter of the north half of lot 1 in the second concession, and the north half of the south-east quarter of the north half of lot 2 in the second concession, both in the township of Coleman. It is owned by the Black Mines Consolidated, Limited.

A shaft has been sunk to a depth of 200 feet. On the first level there is about 50 feet of drifting north and south of the shaft and a cross-cut west 80 feet. On the 200-foot level a cross-cut has been driven west 100 feet and drifts north and south 50 feet respectively.

The plant consists of two 50 horse-power boilers, a 6-drill Sullivan compressor and hoist.

Mr. B. Neilly is superintendent.

Kerr Lake

During 1909 the Kerr Lake Mining Company paid in dividends to shareholders $750,000.

The two shafts from which the production is obtained are No. 3 shaft on the south end of the property, and No. 7 shaft on the north end near the lake. On No. 7 shaft the work during the year was carried on chiefly on the third and fourth levels, from which also the production came. On the third level drifts have been run south 120 feet and north 340 feet. From the north end of this drift, cross-cuts and drifts have been extended east and west, a distance of 350 feet and 300 feet respectively. About 400 feet of drifting has been done on veins and stringers in addition to this. A winze has been sunk to the level below. Most of this working is under the lake. On the fourth level a drift has been extended north 400 feet, and a drift from this 160 feet west, also 200 feet of additional drifting along the veins. Some stoping has been done on both levels. The second level of No. 7 shaft has been connected with No. 3 shaft near the railway by a drift 600 feet in length. From this shaft 1,100 feet of drifting and cross-cutting have been done in addition.

On the first level of No. 2 shaft, just south of the railway, 300 feet of drifting has been done.

On No. 3 vein, work is being done on the fourth and fifth levels. Drifts have been run north and south from the shaft on the fourth level, a total distance of 300 feet, and the same on the fifth level. Stoping is being carried on on both these levels. On the fifth level a winze has been sunk a depth of 50 feet. On the second level a cross-cut has been driven to a point under No. 2 shaft, a distance of 550 feet.

Mr. S. R. Heakes is manager.

Kerr Lake Majestic

The property owned by the Kerr Lake Majestic Mines, Limited, was under option to The Kerr Lake Mining Company during part of 1909. This option was surrendered the last of the year, and no work has been done on the property since that time. The work on the claim consists of one shaft, on the top of the hill, sunk to a depth of 112 feet, and drifts run north, east and west, distances respectively of 150 feet, 175 feet and 225 feet. The shaft sunk near the lake shore has a depth of 150 feet. An adit was also driven from near the lake shore north, a distance of 250 feet.

A power plant, consisting of two 125-h.p. boilers, a 12-drill compressor and hoists, has been installed.

Kerry

The Kerry Mining Company have leases on 20 acres of Peterson lake and the northern part of Cart lake. No work was done on the Cart lake lease in 1909. On the Peterson lake lease the shaft has been sunk a depth of 200 feet, with the first level at 125 feet. From this level drifts have been run north and south from the shaft distances of 125 feet and 150 feet respectively. On the second level a drift has been run south 300 feet.

Mr. Herbert E. Jackman is manager.

King Edward

Work was carried on continuously throughout the year by the King Edward Silver Mines, Limited. The general plan of development and operation of the mines outlined in former Reports has been followed. During the year stoping was carried on in the main vein, and the 10-stamp mill run continuously.

Mr. Glenn Anderson is manager.

La Rose Consolidated

La Rose Consolidated Mines Company paid $1,206,791 in dividends in 1909. Practically all the ore which paid these dividends was taken from La Rose mine. The Princess, Lawson and University were small producers.

Mr. D. Lorne McGibbon is now president of the company, and Mr. R. B. Watson manager. La Rose Consolidated control the following properties:—La Rose, La Rose Extension, Princess, Fisher, Epplett, Silver Hill, University, Violet, Lawson.

Work is being done on the La Rose, Princess, University and Lawson. A brief description of the work done is here given.

La Rose:—The development on the main vein was quite fully described in the last Report. On the 110-foot level a drift has been driven on the vein north 860 feet and south 340 feet, or a total length of 1,100 feet on the vein. A drift has been driven to the Macdonald vein from the 85-foot level of the main vein. On this level of the Macdonald vein, 420 feet of drifting has been done. A winze has been sunk 40 feet from this level, and 150 feet of drifting done from the bottom of the winze. A cross-cut has been run from the Macdonald vein on the 85-foot level to No. 10 vein, and 75 feet of drifting done on it. At a distance of about 200 feet from the main vein and parallel to it, a cross-cut has been driven from the Macdonald vein to No. 3 vein, a distance of 575 feet, and extended south 350 feet from No. 3 vein. No. 3 shaft has been sunk to the 110-foot level, and 220 feet of drifting done, also some stoping on the vein. From this level a cross-cut has been driven northeast 140 feet.

The company are now shipping their low grade ore to the Northern Customs Concentrator for treatment.

Lawson:—Work was begun at this mine in May, 1909. The old Silver Leaf shaft near the north side of the property was pumped out, and drifting begun south, on the 88-foot level. The main shaft was sunk to the same level, and drifts run east, north and south, and the shaft connected underground with the Silver Leaf shaft. The drift south

has been run 250 feet and cross-cuts driven east and west 175 feet. A raise has been put through to the surface on the main vein, 150 feet south of the Silver Leaf shaft. No. 2 shaft is 30 feet deep, with 100 feet of drifting. No. 8 shaft is 40 feet deep, with 75 feet of drifting. No. 11 shaft is 45 feet deep, with 50 feet of drifting.

A shaft house, ore-sorting house and new camp buildings have been erected.

Princess:—The main shaft is now at a depth of 150 feet, with levels at 50 feet and 132 feet. On the 50-foot level about 400 feet of drifting has been done. On the 132-foot level a cross-cut has been driven north 450 feet. On the first vein encountered, 90 feet north of the shaft, 300 feet of drifting has been done, also some stoping. A raise has also been put through to the first level. On the vein 400 feet north of the shaft 110 feet of drifting has been done.

An ore-sorting house has been erected.

University:—The work done at this mine consisted of sinking a shaft 100 feet and doing 100 feet of drifting on the 90-foot level.

An ore-sorting house was erected at this shaft.

Little Nipissing

The Little Nipissing Silver Cobalt Mining Company, Limited, have carried on but little work on J.B. 2 during the last year. They have, however, done considerable development on their 20-acre lease on Peterson lake. The shaft has been sunk to a depth of 160 feet, and on this level there has been about 1,100 feet of drifting and cross-cutting done. A vein of good ore was found during the latter part of the year.

Mr. M. B. Gordon is manager.

Lumsden

The Lumsden Mining Company have been operating on the west half of the north-east quarter of the north half of lot 2, in the third concession of Coleman. Three prospect shafts have been sunk to a depth respectively of 30, 50 and 75 feet. Another shaft, on which work is being done, is 175 feet deep, with some drifting on the 100-foot level, also on the 175-foot level.

Air for drilling is obtained from the Badger Mining Company.

Mr. F. I. Daniels is manager.

McKinley-Darragh-Savage

The McKinley-Darragh-Savage Mines of Cobalt, Limited, under the management of Mr. P. A. Robbins, have operated their mines and mill steadily during 1909. According to the report of the manager there were 2,453 feet of drifting, 2,568 feet of cross-cutting, 99 feet of shafts, 175 feet of winzes and 301 feet of raising done during the year.

The workings have now been carried down to a depth of 250 feet, a winze having been sunk 100 feet deep from the 150-foot level on the lake vein, and 50 feet of drifting done. On the 200-foot level several hundred feet of drifting has been done. Stoping is being done on the 150-foot level.

The 20-stamp mill has been treating from 70 to 80 tons of ore per day during the year. Ten stamps additional are being installed. Motors are being put in the mill to drive all the machinery, electric power being supplied by the Mines Power Company.

Mining work on the Savage has been confined chiefly to No. 3 shaft. This shaft has been sunk to a depth of 140 feet. On the 80-foot level about 425 feet of drifting has been done, connecting with the No. 4 shaft. On the 140-foot level about 100 feet of drifting has been done. No. 2 shaft has been sunk 112 feet. A new shaft house has been erected over No. 4 shaft, the No. 3 shaft house having been destroyed by fire, and an ore-sorting house built, in which crushers and jigs have been installed.

Meteor

The Meteor Mining Company have acquired the northeast quarter of the north half of lot 5, in the fourth concession of Coleman, and have begun operations on the west side of diabase mountain. An adit has been driven east a distance of 250 feet.

Mr. A. Cairn Hodge is manager.

Michigan Cobalt

The Michigan Cobalt Mines have leased from the Amalgamated Cobalt Mines Company the southwest quarter of the south half of lot 3, in the fifth concession of Coleman.

A shaft has been sunk 100 feet, and drifts run east 175 feet and west 200 feet. The plant consists of a small boiler and hoist. Air for the drills was obtained from the Kerr Lake Majestic Mining Company.

Nancy Helen

The Nancy Helen Mines, Limited, were engaged in mining on their property for only part of the year. On the 100-foot level several hundred feet of drifting and cross-cutting has been done, and also some stoping; and on the 190-foot level 200 feet of drifting and cross-cutting.

No work was being done in the mine in February, 1910.

Nipissing

The Nipissing Mining Company paid $1,350,000 in dividends in 1909. The company have paid up to 31st December, 1909, $4,355,000 in dividends.

Work was being carried on at the following shafts at the date of my inspection in February, 1909: Kendall, veins Nos. 49, 122, 26, Fourth of July, Meyer and No. 64. Some other shafts were worked during part of the year, and a great deal of trenching done.

The Kendall continued to be a large producer. On the 140-foot level drifts have been extended west 205 feet and east 300 feet, to the intersection of the vein running northeast by southwest. On this vein 280 feet of drifting has been done. A raise has been put through from the north end of this vein to the surface, and near the south end a winze is being sunk. Stoping has been done on both levels on both the veins. A new ore-sorting house was erected at this shaft.

On vein 49 work has been carried on irregularly. The underground developments have been described in a former Report. The work done on the vein during the year consisted chiefly of underhand stoping the vein from the surface.

On vein 122 a shaft has been sunk to a depth of 150 feet. On the 75-foot level a drift was run west 260 feet, crossing the drift on vein 25. A new shaft house and ore-sorting house have been erected.

On vein 26 the work done was fully described in a former Report. During 1909 most of the work has consisted of stoping on the several levels. A winze is now being sunk from the lower level.

At the Fourth of July shaft, veins Nos. 80 and 100 are being worked. On the 70-foot level, vein 80 has been drifted on for about 300 feet in length, and vein 100 for 380 feet. A cross-cut has also been run south 280 feet. On the 190-foot level 600 feet of drifting and cross-cutting has been done, and a raise put through to the first level.

The Meyer shaft has been sunk 190 feet on vein No. 73, and about 500 feet of drifting done on it.

The shaft on vein 64 has been sunk 270 feet. On the 172-foot level, 300 feet of drifting has been done on the vein, and a raise put through to the first level. On the 270-foot level a drift has been run east 250 feet. A shaft house and an ore-sorting house have been erected.

Mr. R. B. Watson is general manager, and Mr. Hugh Park manager.

North Cobalt

The North Cobalt Silver Mines Company have been developing part of the northwest quarter of the north half of lot 13, in the first concession of Bucke, and have sunk a shaft to a depth of 135 feet, and a winze from a point 75 feet west of the shaft another 50 feet. On the 75-foot level about 500 feet of drifting was done, and about 250 feet on the 135-foot level. Some ore was shipped from the property.

Mr. J. A. Jacobs is president of the company, and Mr. A. M. Bilsky managing director.

Northern Customs Concentrator

The Northern Customs Concentrator, Limited, is an independent company, with mill situated on the town site of Cobalt south of the railway station. In January, 1910, the company had a contract for concentrating the milling ore of La Rose and City of Cobalt mines. Mill rock from the Silver Queen, Townsite and Nova Scotia has also been concentrated by this company. The company either treat the ore at a rate per ton, or

Nova Scotia shaft house and concentrator.

pay for a specified percentage of the silver contents. The company have recently added to their capacity, having now fifty 1,250-lb. stamps and two Nissen 1,500-lb. stamps.

The ore is first passed through a Gates crusher and then sent to rolls, where it is reduced to $\frac{3}{4}$-inch product. From the rolls it goes through a Vezin sampler, and then through a trommel. The fines go direct to a hydraulic classifier, and the oversize to a bull-jig. The tailings from the jigs go direct to the stamps, then to a classifier, the sands going to Wilfley tables and the overflow to callow tank and vanners. The tailings from the vanners again go to a classifier, and the spigot discharge to waste, while the fine product is led over canvas tables.

Mr. M. F. Fairlie is superintendent of the mill.

Nova Scotia

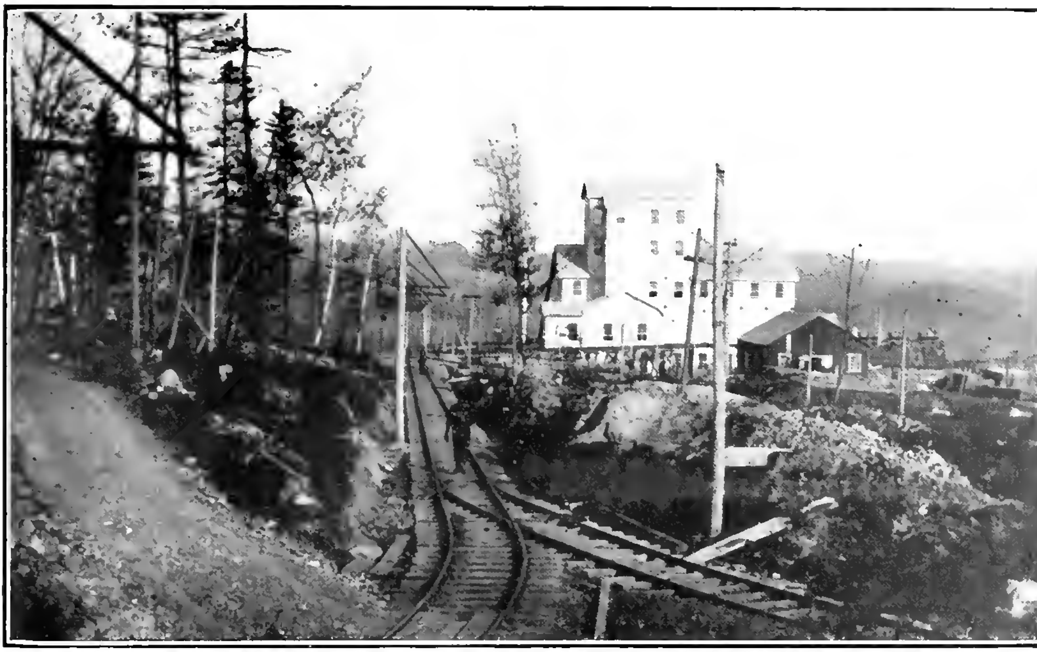
In the company's annual report the amount of underground work for the year was given as 1,977 feet of drifting, 1,619 feet of cross-cutting and 229 feet of sinking. This applied both to the Nova Scotia mine and to the Peterson lake lease. The lease is worked from the Nova Scotia shaft, and consequently the two workings are as one mine. The work done enumerated above has consisted partly of exploratory work. A drift was run from 110-foot level to cut No. 10 vein, which was discovered on the surface

just east of the office. A shaft has also been sunk on this vein to a depth of 75 feet. On the fifth level, west drift, a winze was sunk a depth of 75 feet and drift run to the shaft. The work of raising the shaft to the fifth level has begun.

The No. 3 shaft has been changed into a double compartment hoistway, which necessitated making a new manway through the older workings up No. 1 shaft. A new double drum hoist was installed.

A 20-stamp mill has been erected, and the work of concentrating ores begun in May, 1910. The mill is situated near No. 3 shaft, and the ore is first put through a crusher, over screens, and the oversize through rolls and then to the stamps. The product from the stamps is classified, and the sands run over tables. The whole product is then re-ground in two 18-foot tube mills and then cyanided. A complete equipment of agitating tanks, filter presses and precipitating tanks has been installed.

Mr. A. G. Kirby is manager.



O'Brien mill and electric railway.

O'Brien

Four shafts were being worked at the O'Brien mine in February, 1910. These were: No. 1, No. 2, No. 6 and No. 14. Shaft No. 16 was worked during part of 1909.

The workings of No. 1 shaft remain much the same as described in the last Report. The drift on the 200-foot level of No. 1 shaft has been extended east and connected with the drift west on the first level of No. 6 shaft by a cross-cut and raise. From the 200-foot level east drift, 1,000 feet from No. 1 shaft, a raise is being put through to the surface for the new shaft. This is to be a 3-compartment shaft, and is about 200 feet from the mill. Ore can be trammed underground from No. 1 and No. 6 shafts to this new shaft and hoisted to the surface, from which a short tramway will lead to the mill.

No. 2 shaft has been sunk to the 225-foot level and drifting begun.

No. 6 shaft is 240 feet deep and has levels at 75 feet, 150 feet and 225 feet. Drifts have been extended east and west from the shaft on each level and stoping commenced. From the second level a drift is being driven north to connect with the drift from No. 16 shaft.

No. 14 shaft is 185 feet deep, with levels at 110 feet and 185 feet. On the first level 100 feet of drifting has been done and on the second level 60 feet of cross-cutting.

The concentrator has been in operation since the latter part of 1909. The ore is first crushed and jigged, and then re-crushed by 30 stamps. The coarser product is then treated in tables and the finer ore crushed by tube mills and cyanided. The cyanide department consists of a pulp thickener, agitators, filters, precipitation tanks and slime presses.

Mr. M. T. Culbert is manager.

Ontario Development

The Ontario Development and Mining Company, Limited, have been engaged in development work on lot 1, in the first concession of Coleman.

A shaft has been sunk to the depth of 250 feet, with stations at 150 feet and 250 feet. About 150 feet of drifting has been done at both levels.

A plant, consisting of a 100-h.p. boiler, 3-drill compressor and hoist, has been installed.

Ophir

On the east half of the northeast quarter of the north half of lot 2, in the second concession of Coleman, the Ophir Cobalt Mines, Limited, of which Mr. E. P. Rowe is managing director and Mr. J. A. MacVichie, consulting engineer, were engaged in prospecting and development work during 1909. A shaft has been sunk to a depth of 200 feet, and levels run at 100 feet and 200 feet. On both these levels about 75 feet of drifting had been done at the time of inspection.

A plant, consisting of a 100 horse-power boiler, 6-drill compressor and hoist, has been installed.

Ore Reduction Company

This company kept their concentrator, which is situated on Nipissing property near the Kendall shaft, running most of the year on Nipissing low-grade ore from the Kendall shaft.

The scheme of concentration has been changed from dry to wet process. The mill, when in operation, treats from 60 to 75 tons per day.

Pan Silver

The Pan Silver Mining Company own the south 80 acres of the north half of lot 2, in the third concession of Coleman. Mr. B. E. Cartwright is president, and Mr. Norman R. Fisher manager.

Shaft No. 2 is 200 feet deep, and is connected with the No. 1 shaft, which is about 250 feet distant. On the second level a cross-cut has been driven south 350 feet, and a drift northwest 300 feet. A winze was sunk on this drift a depth of 50 feet at about 250 feet from the shaft.

Peterson Lake

Peterson Lake Silver Cobalt Mining Company, Limited, have 155.8 acres of their property under lease on a royalty basis of 25 per cent. of the gross value of the ore produced.

The following have leases:—Gould Consolidated Mining Company, Kerry Mining Company, Cobalt Leasers Company, Scott, Deville (St. Anthony), Little Nipissing Mining Company, Baird (Union Pacific), Brydge Syndicate (Susquehanna), Nova Scotia. The work done by these concerns will be found noted under their several names.

The company itself did no mining until the first part of 1910, when it let a contract to sink a shaft 150 feet deep.

Pontiac

The Pontiac Silver Mining Company, Limited, acquired the Flynn property near Cross lake and did some development work on it in 1909. A shaft was sunk 75 feet and some drifting and cross-cutting done.

Provincial

The Provincial mine was operated by the Ontario Government until September, 1909, when it was sold to Mr. F. M. Connell for the sum of $113,111 and possession given to him on October 6th, 1909. Since that time Mr. Connell has turned the property over to the Cobalt Provincial Mining Company.

The work done underground has been described in former Reports of the Bureau of Mines. The new company are engaged solely at No. 2 shaft, near the Savage line, which they have sunk to a depth of 100 feet.

Mr. O. N. Scott is manager.

View of Cobalt in distance—Right of Way Company's Buildings in right foreground, and Mines Power Company's transformer and compressor building on left.

Red Jacket

The Red Jacket Silver Mines, Limited, have acquired the property originally known as the Morrison, on the north-west part of the north half of lot 7 in the fourth concession of Coleman.

A shaft has been sunk to a depth of 125 feet and 300 feet of drifting has been done at this level.

A plant was installed consisting of boiler, compressor and hoist. A shaft house and ore house have been erected.

Rex Flinn

On A. 7, one of the lots on the Gillies Limit, sold by the Ontario Government, a shaft 60 feet deep has been sunk and some surface work done.

Right of Way

The Right of Way Mining Company confined their work in 1909 to the No. 3 shaft. This shaft is 75 feet deep with cross-cut of 60 feet to No. 1 vein. On this vein, which extends across the right of way, considerable stoping has been done and a winze sunk to the 120-foot level, where 125 feet of drifting has been done. The main cross-cut has been extended north on the 75-foot level, a distance of 330 feet, where No. 2 vein was

encountered. On this vein 120 feet of drifting was done and a winze sunk to the 120-foot level, where a drift was run 120 feet. The main cross-cut has been extended a further distance of 600 feet, cutting veins on which 250 feet of drifting was done. Near No. 3 vein, or 740 feet north of No. 3 shaft, a raise was put through to the surface and timbered, which is now used as a working shaft.

The work at No. 2 shaft ceased the latter part of the year. The workings remain much the same as described in the last Report. The stopes on the known veins have been worked out.

Rochester

The Rochester Cobalt Mines, Limited, were engaged in development work on their property during part of 1909. The main shaft is now 165 feet deep, with a level at 150 feet, on which 200 feet of drifting and cross-cutting has been done. On the first level about 300 feet of drifting and cross-cutting was run.

Another shaft was begun the latter part of the year about 400 feet south of the main shaft. This was sunk to a depth of 75 feet.

Mr. A. M. Carroll is superintendent.

St. Anthony

The St. Anthony Prospecting, Developing and Mining Company, Limited, have a lease on Peterson lake opposite the Little Nipissing lease on the east shore of the lake. A shaft has been sunk to a depth of 150 feet, and a small upright boiler and hoist installed. Father Joseph Zubeycki is president of the company. The directors have passed a by-law by which one-quarter of all the dividends that may be declared shall be given to charity.

St. Lawrence

The St. Lawrence Cobalt Consolidated Mining Company have been developing a claim on an island in Sasaginaga lake. A shaft has been sunk to a depth of 75 feet and some trenching and test pitting done.

Mr. W. E. Waterman is president of the company.

Shamrock

The Shamrock Silver Mining Company, Limited, have been developing the south half of the south-west quarter of the south half of lot 1 in the fourth concession of Coleman The shaft is now 300 feet deep. On the first level 800 feet of drifting and cross-cutting has been done, on the second level 1,200 feet and on the third level 100 feet. Winzes have been sunk from the first to the second level, and from the second level to a depth of 70 feet.

On the leased lot north of the Shamrock the company have been doing considerable trenching and prospecting. A shaft was sunk to the depth of 100 feet.

Silver Bar

Very little work was done by the Silver Bar Mining Company in 1909. The work done consisted of sinking a new shaft a few feet and doing some drifting and cross-cutting. Several hundred feet of diamond drilling was also done by the company during the year, using the Government drill.

Silver Cliff

This property was sold by the original owners in June, 1909, and since that time active development work has taken place. The main adit has been driven into the hill a distance of 340 feet. On No. 1 vein, cut by the adit, 460 feet of drifting has been done south-east of the adit, and 220 feet north-west. On this vein some stoping was done, and a winze sunk a depth of 60 feet. On No. 2 vein drifts have been run south-east 260 feet, and north-west 100 feet. On No. 3 vein the drifts have been extended south-east 120 feet, and north-west 110 feet.

The company have erected a 100-ton concentrating mill. The ore is hoisted to a storage bin at the top of the mill. From this it is fed into a No. 5 Austin gyratory crusher, thence to two sets of rolls, and thence over trommels. From the trommels the ore goes to 4 jigs, the tailings from the jigs passing to a 6-foot Chilian mill for re-grinding. From the Chilian mill it goes to classifiers, and thence to 9 Traylor sand tables and 3 Traylor slime tables. The mill was put in operation in April, 1910.

Mr. A. R. Peacock is president and Mr. John J. Moore manager of the company.

Silver Cross

The Silver Cross Mines, Limited, worked steadily during 1909. The shaft was sunk to a depth of 125 feet and about 200 feet of drifting done on the 75-foot level.

The plant installed consists of a 60 horse-power boiler, 3-drill compressor and hoist. This company have been furnishing the Belmont and the E.T. Mining Company with power.

Mr. L. Brown is manager.

Temiskaming mine.

Silver Leaf

In December, 1909, the Silver Leaf Mining Company leased their holdings for five years to the Crown Reserve Mining Company, at a royalty of 25 per cent., the latter agreeing to spend the first year $20,000 and $10,000 each year thereafter for four years.

During the year most of the development work took place in the main shaft near the Crown Reserve line, and in sinking a new shaft about 400 feet north of the lake. This shaft was put down to a depth of 200 feet. It is the purpose in this shaft to sink through the diabase into the slate formation underlying it and there prospect for veins. In the main shaft 300 to 400 feet of drifting and cross-cutting has been done.

Mr. S. Cohen is manager.

Strathcona

The Strathcona Silver Mining Company continued to carry on development work on the southeast quarter of the north half of lot 10 in the second concession of Bucke during 1909. About 205 feet of drifting was done from the 75-foot level.

Susquehanna

The Susquehanna Mining Company, Limited, have a lease on the north end of Peterson lake, and were operating during all of 1909. A shaft has been sunk to a depth of 210 feet and 400 feet of drifting done under the lake.

The plant consists of a 6-drill compressor, a 100 horse-power boiler and a hoist.

Mr. E. A. Niel is president of the company.

Temiskaming

The Temiskaming Mining Company have been working during 1909 chiefly on the 250-foot and 350-foot levels. On the 250-foot level the main drift north is 240 feet in length and south 500 feet. Some 600 feet of drifting and cross-cutting have been done besides these main drifts. On the 300-foot level drifts have been run north 120 feet, and south 125 feet to the winze which is sunk to the 350-foot level. From this winze a drift has been run south-west 200 feet. From the latter two other drifts have been run north and south 120 feet each respectively. The winze has been sunk 50 feet. From the bottom of this winze, drifts have been run south-west 220 feet under No. 1 shaft and north 80 feet. Considerable stoping has been done on the 250-foot and 300-foot levels.

A concentrating mill was erected on the north-west corner of the property the latter part of 1909. The ore is taken from the ore-sorting plant at the shaft by aerial tram to the top of the mill, where, after being crushed to ¾-inch, it goes over trommels for sizing, and thence to jigs. The tailings from the jigs are re-crushed by 30 stamps. The product from the stamps goes to a classifier, and from there to tables. The tailings from the tables are re-ground on a tube-mill and are treated on slime tables. The mill is expected to handle from 80 to 90 tons per 24 hours.

Mr. B. E. Cartwright is president of the company and Mr. Norman R. Fisher manager.

Temiscaming and Hudson Bay

The Hudson Bay Mines, Limited, was organized in September, 1909, to take over the holdings of the Temiscaming and Hudson Bay Mining Company. This company have paid $1,171,911 in dividends.

The work during the year at this property was done chiefly on the third and fourth levels. On the third level, 1,450 feet of drifting and cross-cutting has been done, besides considerable stoping. On the fourth level the main drift east on the vein is 400 feet in length. From a point in this drift 140 feet from the shaft a drift has been run to the Trethewey line.

In the ore house a jig and a Wilfley table have been installed for treating the low-grade screenings.

The company have purchased some claims at Gowganda, and are doing development work on them.

Trethewey

The Trethewey Silver Cobalt Mines, Limited, have paid $461,998.50 in dividends. In addition to this the mine produced considerable ore while it was being operated by the original owner, Mr. W. G. Trethewey.

The chief work in the mine last year was done from No. 2 shaft. On the sub-level, between the first and second levels, 700 feet of drifting has been done; and on the second level, 900 feet of drifting and cross-cutting. On the third level the drift east is 168 feet in length. About 200 feet of drifting and cross-cutting has been done on this level.

No. 4 shaft, about 100 feet from the Hudson Bay line, on the north side of the property, has just been completed. It is 200 feet deep. On this level about 500 feet of work was done by the Hudson Bay Mining Company under contract, before the shaft was completed, they also having raised part of the shaft.

The 30-stamp mill being erected by the company is expected to be in operation in May, 1910. The system of concentration is very similar to other stamp mills in the camp. The ore is crushed to ½-inch product by a jaw crusher. It then goes to jigs, and the tailings from there to stamps. The product from the stamps goes to a classifier and thence to tables. A tube-mill is being used for fine-grinding the tailings from the tables. This is treated on slime tables. The mill will have a capacity of 80 to 90 tons per day.

Victoria

No work was being done by the Victoria Silver Cobalt Mines, Limited, the latter part of the year, a fire having destroyed their plant. Several shafts have been sunk to varying depths. In all, about 650 feet of shaft sinking has been done, and 750 feet of drifting and cross-cutting.

Waldman

Lots A. 10, A. 12, A. 13, A. 21, A. 22 in the Gillies Limit were purchased from the Ontario Government in 1909 and have since been operated by the Waldman Silver Mines, Limited, with Mr. C. A. O'Connell as manager.

On A. 22 a discovery was made and a shaft sunk to a depth of 85 feet. A level was run at 75 feet on which drifts were driven east 25 feet and west 400 feet. Crosscuts were extended north 40 feet and south 75 feet. Some stoping was done east of the shaft.

A shaft house and ore house have been erected and a 10 x 12-inch hoist installed. Air has been bought from the Provincial mine and from the Wyandoh. A considerable amount of trenching has been done on all the lots.

Webb

On A. 2 in the Gillies Limit a shaft has been sunk to a depth of 50 feet and some trenching done.

Wyandoh

The Wyandoh Silver Mines, Limited, have acquired lots A. 15, A. 23, A. 26, and A. 39 in the Gillies Limit.

On lot A. 23, which was purchased from Messrs. Young and O'Brien, a shaft has been sunk a depth of 100 feet and some drifting done.

A power plant, consisting of two 80 horse-power boilers, a 6-drill compressor and hoist, has been installed.

Dr. Milton Hersey is president of the company and Mr. B. Neilly engineer in charge.

Yorke-O'Brien

On A. 6 a shaft has been sunk to a depth of 150 feet, with 40 feet of drifting on the 100-foot level. The property adjoins the Red Jacket.

South Lorrain Silver Mines

Considerable interest was shown in the South Lorrain area in 1909, caused partly by the shipment of ore from the Wettlaufer mine. Other discoveries of interest were made during the year, and as a result active development work is being carried on at a number of properties.

Bellellen

This property was originally known as the Newman, and was taken over from the original owner the latter part of 1909.

Considerable trenching had formerly been done on this claim. The present owners, under the direction of Mr. Norman R. Fisher, have sunk a shaft 75 feet and drifted 100 feet.

Haileybury Frontier

The Haileybury Frontier Mining Company are operating on the south half of H.R. 16.

Shaft No. 1 is 90 feet deep, with drifts on the 75-foot level driven south-west 125 feet and north-east 60 feet. No. 2 shaft, about 500 feet south-west of No. 1, is 110 feet deep with some cross-cutting.

Power for hoisting and drilling is being obtained from the Keeley mine.

Mr. Lawrence Brown is consulting engineer.

Haileybury Silver

The Haileybury Silver Mining Company sold the south 20 acres of H.R. 16 in 1909 to the Haileybury Frontier Mining Company.

Some sinking had been done by them on this part of the lot. On the north 20 acres the mining work has consisted chiefly of sinking a shaft 100 feet deep and drifting 25 feet on this level. The surface work consists of trenching.

Mr. Cyril T. Young is president of the company.

Keeley

The first discovery of silver in South Lorrain was made on this property. Work has been carried on continuously here since the fall of 1907.

No. 1 shaft is now at a depth of 150 feet, with levels at 65 feet and 135 feet. On the first level drifts have been run east 150 feet and west 150 feet and some stoping done. On the second level, drifts have been driven 75 feet east and west respectively. Shaft No. 3, about 600 feet south of No. 1, is 70 feet in depth.

The plant consists of a gas producer, one 150 horse-power gas engine to drive the compressor of 10-drill capacity, a 40 horse-power high-speed gas engine driving a 40 kilowatt generator, electric hoist and electric pump at the lake about 2,300 feet distant.

Maidens

The Maidens Silver Mining Company have been operating claim H.R. 70, which is situated about one mile north-west of the new government dock.

In addition to trenching and test pitting, two adits have been driven, No. 1 having a length of 285 feet and No. 2, 225 feet.

Jowsey-Woods

Messrs. Jowsey and Woods have been operating on claims H.R. 21 and 22, lying west of and adjoining the Keeley mine. A shaft has been sunk to a depth of 110 feet and, on the 75-foot level, 75 feet of drifting done.

Little Keeley

On the claim west of the Haileybury Silver claim, Mr. Charles Keeley has been doing development work. In addition to surface work, a shaft has been sunk 75 feet and 50 feet of drifting done.

A boiler and hoist have been installed.

Wettlaufer

The Wettlaufer mine is the largest producer in South Lorrain. Active work was begun about the first of 1909.

A plant was installed consisting of two 60 horse-power boilers, a 5-drill straight line compressor and hoist.

The main shaft is 150 feet deep, with first level at 65 feet and second level at 140 feet. On the first level on No. 1 vein, drifts have been run south 190 feet. No. 2 vein

is cut by a cross-cut from the shaft 79 feet in length. On this vein some 200 feet of drifting has been done. It joins No. 1 vein about 100 feet southwest from the shaft On the second level the drift southwest from the shaft is 300 feet in length and is driven northeast 175 feet. At a point 75 feet southwest of the shaft a winze is being sunk having a depth at date of inspection of 32 feet. No stoping of any amount has been done.

Mr. A. C. Bailey is superintendent.

Elk Lake Area

A number of the prospects in this area were not inspected during 1909. Some of the properties on which considerable work was done have recently ceased operations. The only property that shipped ore in any quantity is the Lucky Godfrey. A carload was sent out from this mine during the early part of 1910. A number of the prospects will not be mentioned in this Report, as there has been no opportunity as yet to inspect them.

British American

Some work was done on this property which adjoins the Otisse, but all work had ceased at the time of my inspection.

Big Six

The Big Six Silver Mines, Limited, have been operating a property about one mile northwest of the town of Elk Lake. A shaft has been sunk to a depth of 194 feet, and on the 100-foot level 60 feet of drifting done.

The plant consists of two 50 horse-power boilers, a 3-drill straight line compressor and hoist.

Mr. A. Keys is manager.

Devlin

The Devlin Mining Company have been carrying on mining operations on the northeast quarter of the south half of lot 1, in the first concession of James.

No. 1 shaft has been sunk to a depth of 100 feet, and on this level 125 feet of drifting and cross-cutting done. No. 2 shaft has been sunk 50 feet, and No. 3 shaft 20 feet. In addition to this, considerable trenching and stripping has been done.

A plant was installed on this property during the early part of 1910.

Elk Lake Discovery

Work was carried on by the Elk Lake Discovery Mining Company during part of 1908 and 1909, but all work ceased in the latter part of 1909. A shaft was sunk to a depth of 150 feet and a drift run north-east 75 feet and north-west 287 feet. Some test pits were also sunk.

The plant consists of two 50 horse-power boilers, a 6-drill compressor and hoist.

Gavin-Hamilton

The Gavin-Hamilton Mining Company went into the hands of a receiver the latter part of 1909.

A shaft had been sunk to a depth of 160 feet and drifts run east 95 feet and north 100 feet.

The plant consists of an 80 horse-power boiler, a straight line compressor and hoist.

Langham

The Langham Mining Company have been operating on a claim adjoining the Gavin-Hamilton. Considerable surface prospecting has been done and a shaft sunk to a depth of 60 feet.

Lucky Godfrey

On the claims in the southeast corner of the township of James, the Lucky Godfrey Silver Mining Company have been carrying on development work. A car of ore was shipped from these claims in March, 1910.

A shaft was sunk 50 feet and an open cut carried along the vein from which the ore was obtained.

A plant was purchased in March, 1910, but owing to the early break-up of the roads it did not reach the property.

Motherlode

The Motherlode Mining Company have been carrying on work in the northwest quarter of the south half of lot 8 in the sixth concession of James, about one and a half miles northwest of the town of Elk Lake. An adit has been driven 365 feet, a raise put up 25 feet and a winze sunk 50 feet on the vein. Near the mouth of the adit a shaft has been sunk a depth of 100 feet. Hoisting is done by horse whim.

Moose Horn

The Moose Horn Mines, Limited, carried on work steadily during last year. The main shaft has been sunk to a depth of 125 feet, and about 250 feet of drifting and cross-cutting done.

Otisse

The Otisse Mining Company have been working steadily on mining location E.B. 21 near Silver lake. Early in 1909 a plant was installed consisting of two 80 horse-power boilers, 10-drill compressor and hoist.

The main shaft has been sunk a depth of 150 feet. On the 75-foot level about 600 feet of drifting and cross-cutting has been done, and on the 150-foot level about 150 feet.

Mr. C. C. Williams is superintendent and Mr. F. C. Loring managing engineer.

Otisse-Currie

This mine is west of and adjoining the Otisse. It was in operation during part of 1909, but the company went into a receiver's hands the last of the year.

A shaft was sunk to a depth of 100 feet and about 250 feet of drifting was done.

Tee Arr Mining Company

On this claim, situated about three miles west of Elk Lake near the road to Gowganda, considerable development work has been done. Two shafts have been sunk to depths of 75 feet and 50 feet respectively, and about 100 feet of drifting done.

Silver Alliance

The Silver Alliance Mining Company carried on mining work during 1909. No. 1 shaft has been sunk to a depth of 100 feet and 200 feet of drifting and cross-cutting done.

Power was obtained from the Elk Lake Discovery Mine.

Tudhope

Adjoining the Silver Alliance property, the Tudhope Silver Mining Company have done considerable development work. One shaft has been sunk to a depth of 300 feet and some drifting and diamond drilling done.

Maple Mountain Area

On a number of claims in this area the assessment work was done, and on a few some underground development.

The property on which the greatest amount of work has been done is the White claim.

White

The White Reserve Mines, Limited, were operating on claim R.S.C. 56 until the first part of 1910, when the company ceased work owing to financial difficulties.

The work done consisted of sinking a shaft to a depth of 140 feet. On the 75-foot level a cross-cut was driven south 200 feet to cut vein No. 7, and 100 feet of drifting was done on this vein. On the second level a cross-cut was driven north 125 feet. On vein No. 21 an adit was run a distance of 200 feet. Six and a half tons of ore were shipped in 1909.

Gowganda Area

Considerable development work has been done on a large number of claims that were not inspected. The new government road from Elk Lake to Gowganda will materially help in the development of the camp during the present year. In 1909 the cost of supplies when landed in Gowganda was excessive, as everything taken in during the summer had to be carried by canoe, and there were a large number of portages on the water route between Elk Lake and Gowganda.

The location of these properties is shown on the geological map of Mr. A. G. Burrows, which accompanies Part II. of this Report of the Bureau of Mines.

Bartlett

The Bartlett mine ceased operation the latter part of 1909, owing to financial difficulties.

The work done up to the middle of October consisted of sinking No. 1 shaft to a depth of 115 feet. On this level cross-cuts were run north 135 feet and south 135 feet. About 1,000 feet southwest of No. 1 shaft, No. 2 shaft has been sunk to a depth of 110 feet, and some drifting done.

The plant consists of two 80 horse-power boilers, a 12-drill compressor and hoists at both shafts.

Mr. A. S. Stevens was superintendent.

Boyd-Gordon

This mine was inspected in October, 1909, and in March, 1910. The shaft has been sunk to a depth of 150 feet. On the 75-foot level cross-cuts have been driven north and south each a distance of 140 feet, and about 150 feet of drifting was done on the veins. A sub-level has been run at a depth of 40 feet and some stoping done.

The plant consists of two 50 horse-power boilers, a 6-drill compressor and a hoist.

Bishop

The Bishop Silver Mines, Limited, have been working on T.C. 136, and doing assessment work on a number of other claims. On the above lot a shaft has been sunk to a depth of 65 feet.

Everett

The Everett Lake Mining Company and the Le Heup Mining Company carried on considerable prospecting work on their claims near Everett lake in 1909. A number of test pits were sunk and trenches run.

Bonsall

Messrs. Sifton and O'Brien carried on mining operations during the greater part of 1909 on the Bonsall claims, R.S.C. 82, 83 and 84, which lie north of the Millerett. The main shaft has been sunk to a depth of 135 feet, with about 25 feet of cross-cutting on this level. On the 30-foot level, a drift was run east 80 feet and a drift on a cross-vein 60 feet. On the 75-foot level 50 feet of drifting has been done. No. 2 shaft, on the south side of the property, is 50 feet deep with some drifting.

The plant consists of two 50 horse-power boilers, a straight line compressor and hoist.

Mr. F. P. Aylwin is manager.

Gates

This property consists of claims R.S.C. 90 and 91, lying south of the Millerett. No. 1 shaft is 95 feet deep, with a 25-foot cross-cut driven from the bottom of the shaft. On the 65-foot level, a drift was run north 65 feet and south 48 feet. No. 2 shaft is 65 feet deep with a drift south 54 feet and a cross-cut east 15 feet.

The plant consists of two 50 horse-power boilers, a 6-drill compressor and two hoists.

Mr. K. D. Woodworth is superintendent.

Jacques

The property adjoins the Bartlett to the south. No work was being done on it at the time of inspection. Two shafts were sunk to depths of 35 and 40 feet respectively.

La Brick

The La Brick claims adjoin the Mann property on the east. Two shafts were sunk to a depth of 40 and 45 feet respectively during the summer of 1909. Work was resumed on the claims in March, 1910, under the direction of Mr. O. Henry.

Le Roy

The Le Roy Lake Syndicate have been prospecting on a number of claims near Le Roy lake.

No. 1 shaft has been sunk 100 feet. No. 2 shaft is 45 feet deep. Near this shaft two diamond drill holes have been put down, one 165 feet deep and the other 492 feet. No 3 shaft, near the Morrison claim, is 35 feet deep.

Mr. W. R. Asquith is manager.

Miller Lake

The Miller Lake Syndicate had a large gang at work during 1909 prospecting their claims between Miller and Everett lakes. A large amount of trenching was done, and some shafts sunk to depths of 35 to 50 feet.

Mann

The Mann Mines, Limited, have been engaged in development work on H.R. 251 and 252. The main shaft has been sunk 75 feet deep with a drift east 125 feet, and a cross-cut north 140 feet. A little open cutting has been done on this vein. Two other shafts have been sunk to depths of 40 and 50 feet respectively. During the summer systematic trenching was done on the claim.

Mr. A L. Winckler is superintendent.

Millerett

The Millerett Silver Mining Company, R.S.C. 95, have been the largest shippers in the Gowganda area. The first work done was driving an adit on the vein. This has a length of 195 feet, and 85 feet of the vein above the adit has been open cut. The vein dips to the west at an angle of about 25 degrees from the vertical. Shaft No. 1 is sunk vertically near the mouth of the adit to a depth of 83 feet. The level is at 70 feet and drifts have been run southwest 290 feet and northeast 150 feet. A raise has been put through from this level to the adit level on the vein, and a winze sunk a depth of 40 feet. Stoping is being carried on between the adit level and the first level. From the adit level a cross-cut has been driven west to No. 2 vein a distance of about 150 feet. No. 2 shaft is 60 feet deep with drifts run north 55 feet and south 145 feet on the 50-foot level. Several prospect pits have been sunk to depths of 10 or 12 feet and considerable trenching done.

The plant consists of three 50 horse-power boilers, two 3-drill straight line compressors, 2-feed water heaters, 2 hoists and pumps.

Mr. G. M. Colvocoresses is manager, employing an average of 60 men.

Mackay

The Mackay property adjoins the Morrison on the south and is about $3\frac{1}{2}$ miles east of Gowganda lake.

A shaft has been sunk to a depth of 80 feet and about 50 feet of drifting done at the 50-foot level.

Mr. C. B. Flynn is manager.

Morrison

The work done on this claim consists chiefly of trenching. A test pit about 10 feet deep has been sunk on the main vein. The property is owned by Major Morrison of Ottawa and associates.

O'Kelly

This property adjoins the Jacques on the east. The work done during 1909 consisted chiefly of trenching and test pitting.

Reeves-Dobie

This mine is being operated by the Gowganda Pilot Silverlands, Limited, with Mr. J. G. Harris as manager.

Two cars of ore were shipped from the property during the winter, constituting it the second largest shipper in the Gowganda area. A shallow open cut was carried along the vein from which the ore was obtained. The main shaft has been sunk to a depth of 65 feet and a drift driven south a distance of 150 feet. In addition to this a number of test pits were sunk, and a considerable amount of stripping done.

A plant, consisting of two 50 horse-power boilers, the high pressure half of a 10-drill compressor and a hoist, has been installed.

Silvers, Limited

This property is also known as the Armstrong fraction. A shaft has been sunk to a depth of 100 feet and a drift run north a distance of 75 feet. A small boiler and hoist have been installed.

Mr. M. Kennedy is superintendent.

Transcontinental

This property is situated about two miles west of the north-west arm of Gowganda lake. A shaft has been sunk a depth of 75 feet and a small plant installed.

Welsh

This property lies south of and adjoining the Reeves-Dobie. Some trenching and test pitting was done on it during 1909, but active mining operations were begun under Mr. Moses Joy as manager in March, 1910.

Larder Lake Area

Assessment work was done on a large number of claims in this area during 1909. On some of the more important properties, considerable work was done, and on one a stamp mill was run. On account, however, of the intermittent operations throughout the whole of the camp, no inspection was made during the year.

In the townships of Munro and Guibord a number of claims were staked for gold in the fall of 1908 and some work was done during 1909. The Munro Mines, Limited, have probably done the most development work. On this property, which is in the township of Munro cornering on Guibord, a shaft has been sunk to a depth of 70 feet, and some stripping done on the vein on surface.

About five miles north of Dane and one-half mile from Swastika station, T. & N.O. railway, the Swastika Mining Company have been engaged during the last two years in developing a gold prospect. A shaft has been sunk to a depth of 100 feet and some drifting done. A two-stamp mill was installed the latter part of 1909, and some mill runs made.

Porcupine Area

In the townships of Whitney and Tisdale gold discoveries were reported in the latter part of 1909. A large number of claims were staked during the fall and winter, but very

South Porcupine.

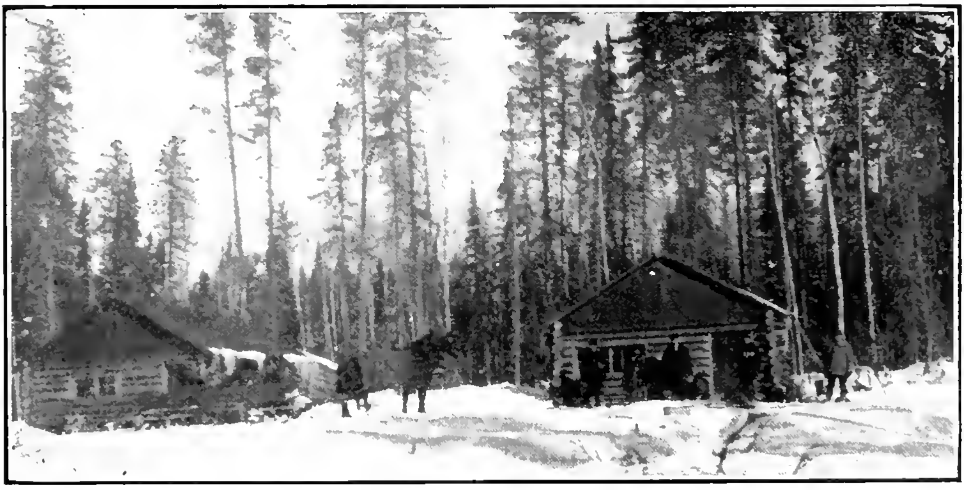
Government Townsite, Porcupine.

little actual mining work has yet been done in the camp. Porcupine lake is central for the two townships mentioned, and on its shores three towns are already in embryo. On a hurried inspection tour in March, 1910, the following properties were inspected:

Bannerman

These claims are about one and a half miles north of Porcupine lake, and are being developed by the Scottish Ontario Gold Mining Company, with Mr. P. McLaren as manager.

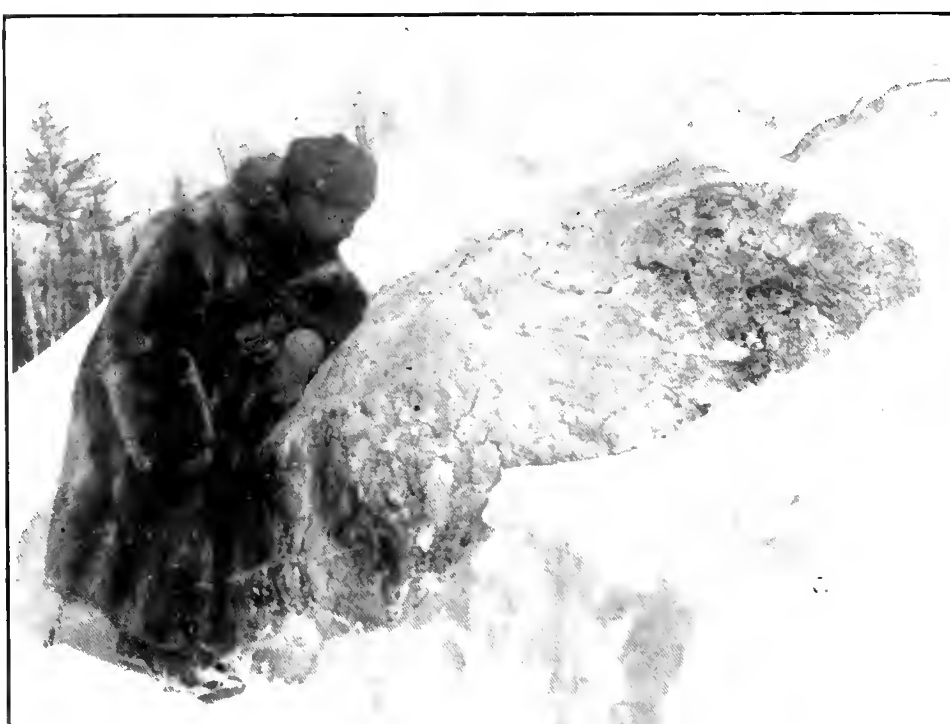
Bannerman Claims, Porcupine.



Camps at Dome Mine, Porcupine.

A shaft has been sunk a depth of 22 feet and two of the veins stripped for a considerable length.

No. [illegible] Shaft [illegible] Hollinger mine, Porcupine.



Outcrop of Quartz at Timmins (Hollinger) mine, Porcupine.

Dome

No work was done on these claims other than some stripping. The claims have been taken over by the Dome Mines, Limited, and active development work begun under the supervision of Mr. John Lawson, of the Canadian Copper Company.

A plant was taken in before the break-up and is now in operation.

This property is situated about two miles west of Porcupine in the township of Tisdale.

Hollinger

The Hollinger claims are situated about four and a half miles west of Porcupine lake and a mile and a half east of the Mattagami river. They are being developed by Messrs. Timmins, McMartin and Dunlap, the original owners of La Rose mine at Cobalt.

Bagging ore for sample shipment at Timmins (Hollinger) mine, Porcupine.

On these claims the most work in the area had been done at the time of inspection. Three shafts had been sunk to a depth of 55 feet, 35 feet and 20 feet respectively. On the deeper shaft a cross-cut was being driven north and south from the 50-foot level.

A plant, consisting of boilers and compressor, was on the ground and was being set up.

A carload of ore was shipped from the property during the winter.

Miller

Some work was done on the Miller claims, which adjoin the Hollinger on the northwest, by Mr. M. J. O'Brien, who held the claims on an option. A couple of test pits were sunk, and 205 feet of diamond drilling done.

O'Brian-Foley

About one-half mile west of Porcupine lake Messrs. O'Brian and Foley have begun development work on a claim. A shaft has been sunk a depth of 25 feet, and some stripping done.

Temagami Area

In the area between Latchford and Temagami there is one mine shipping iron pyrites and two mines that have shipped mispickel and chalcopyrite. Work has been done on a number of claims for gold, molybdenite, silver and copper.

Northland

This mine was closed for a few months in 1909, but is now operating steadily. The main shaft has a depth of 300 feet, with levels at 100 feet, 175 feet and 275 feet. A winze was sunk from the second level, 75 feet north of the shaft, a depth of 100 feet, a drift run to the shaft, and the shaft raised to the second level. Underhand stoping is now being carried on from the stope between the second and third levels. No other work was being done at the time of my inspection.

Mr. J. Hanna is manager.

Sterling

No work is being done by the Grey's Siding Development Company at this property, which is situated about three miles from Grey's Siding, T. & N.O. railway. Some open cut work was done in 1909, and a quantity of ore shipped.

Temagami Gold Reef

The Temagami Gold Reef Company have been developing a property on the west side of Net lake, which carries some gold and molybdenite.

One shaft has been sunk a depth of 75 feet and another a depth of 50 feet.

Temagami Cobalt

On the east shore of White Bear lake the Temagami Cobalt Mines, Limited, have been engaged in development work on their claims. A number of shafts have been sunk, one on T.R. 1609 having a depth of 100 feet, and one on T.R. 1836 a depth of 75 feet, with some drifting.

IV.—EASTERN ONTARIO

Eastern Ontario is unique in the possession of a great variety of minerals, some of which are of rare occurrence in economic quantities. Of these minerals the following are mined and shipped: Gold, copper pyrites, talc, iron pyrites, galena, zincblende, amber mica, apatite, graphite, arsenopyrite, iron ore (both magnetite and hematite), feldspar, quartz, corundum, fluorite and barite. Sodalite also occurs near Bancroft, and a little has been taken out for use as a decorative stone. Marble, granite and limestone are quarried and used for building purposes. There is probably no better limestone for building purposes than the Birdseye and Black River limestone, which occurs in the vicinity of Kingston, from which occurrence the name Limestone City is derived.

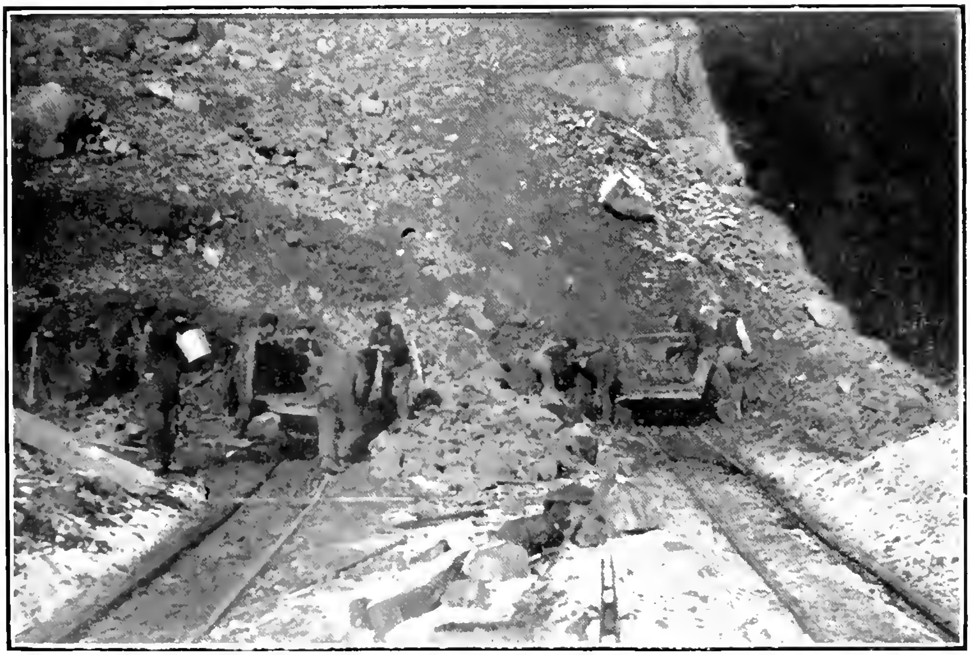
A number of properties are, however, worked intermittently, particularly the gold properties. The first production of iron pyrites dates back only a few years, but it is now an important industry, and an acid plant has been erected at Sulphide by the Nicholls Chemical Company for treating the ore at the mine.

Eastern Ontario has for many years been a large producer of amber mica; in fact, nearly all the amber mica used in America comes from eastern Ontario and that part of Quebec north of the Ottawa river tributary to the city of Ottawa. A number of mica properties were worked between 1870 and 1890 for apatite when the price for that mineral was high. About the year 1891, on account of the discovery of large beds of animal phosphate or guano in Florida, the price of phosphate dropped so low that all the phosphate mines in Ontario had to cease operations. About the same time, however, the demand for mica began, and since that time the production of mica has been a very important industry in eastern Ontario. The market for it fluctuates with the industrial activities of America, on account of its being chiefly used in electrical machinery. This was very marked in 1907 and 1908, when, owing to the financial depression, the large

electrical companies had to curtail operations. As a consequence most of the mica mines had to cease operations for a time, owing to there being no market for their mica. Conditions have improved vastly during the last year, and the price paid for thumb trimmed mica at present is as follows:—

1" x 1"	4 to 5	cents	per pound.
1" x 1"	8 to 10	"	"
1" x 3"	15 to 18	"	"
2" x 3"	35 to 40	"	"
3" x 4"	55 to 60	"	"
3" x 5"	75 to 80	"	"
4" x 6"	90 to 100	"	"

In 1902 the value of mica produced in Ontario was $102,500, being the largest returns that have been received. This is the value of the mica in its rough condition as taken from the mines.



Open pit, Mayo iron mine, No. 4.

Corundum is another mineral which has provided an important industry for Ontario. In 1906 the value of corundum produced in Ontario was returned as $262,448. During 1909 the Canada Corundum Company leased their property to the Manufacturers' Corundum Company, who have since been operating it.

There has been a small production of talc from the Henderson mine near Madoc for some years. It was all shipped to the United States. During the latter part of 1908, Mr. Geo. H. Gillespie began the erection of a mill for grinding the talc. Since that time he has developed an important industry, necessitating the operation of the mine all the year and supplying practically all the trade demands for ground talc in Canada. The capacity of the mill has been more than doubled.

There was only a small gold production from eastern Ontario in 1909. The Gilmour Mining Company operated their mine near Gilmour for a short time, and the Golden Fleece mine near Flinton was worked intermittently on a small scale.

Iron

Mayo

The Canada Iron Corporation operated the Mayo mine, near Bessemer, under lease from the Mineral Range Iron Mining Company, during 1909 and up to May 1st, 1910, when they surrendered the lease.

Work has been confined to No. 4 shaft, which has been sunk to a depth of 120 feet. On this level drifts have been driven east 75 feet and west 100 feet. Stoping is being carried on from both sides of the shaft. On the west side the ore is being taken out by underhand stoping to the winze, which was sunk about 30 feet from the shaft. On the east side a raise has been put through to the bottom of the open pits. The open cut east of the shaft has been carried down below the first level for a length of 150 feet. The ore was shipped by way of the Bessemer and Barry's Bay railway, about five miles to the Central Ontario railway, to the company's furnace at Midland.

Rankin

This property was sold under option by Messrs. Coe and Rankin to Mr. H. H. Lang and associates. No work other than stripping has as yet been done on it.

Iron Pyrites

Sulphide

The work at this mine has been confined chiefly to the third level and below it. Some stoping has been done on the third level stope. The main shaft is only sunk to this level. From the bottom of the winze sunk on the north vein, a cross-cut has been driven to the south vein and 290 feet of drifting done on it. On the north vein on this level 360 feet of drifting has been done. On the south vein a winze has been sunk another 75 feet to the fifth level and 100 feet of drifting done. A raise was also put through to the third level on the south vein over the winze to the fifth level. This raise is to be continued to the surface, and used as a new shaft.

The ore used at the acid works, located about 500 feet from the shaft, has been largely taken out by development work.

The company have been engaged during the last few months in putting in machinery to double the capacity of the acid plant and to manufacture hydrochloric acid. Electric power is to be used to operate the machinery at the mine and acid works, being obtained from the Seymour Power and Electric Company at Campbellford.

Craig

Mr. B. A. C. Craig has been developing an iron pyrites property near Sulphide. A shaft has been sunk to a depth of 200 feet, with drifts run west 125 feet and east 90 feet on the first level, and west 25 feet and east 25 feet on the second level. Some stoping has been done on the first level, and ore shipped to the Nicholls Chemical Company's plant at Sulphide.

The plant consists of a small boiler and hoist.

Zinc

Richardson or Olden Mine

During the year the work at this mine has been confined to the new vein which lies about 400 feet northwest of the old workings. On this vein a number of test pits have been sunk and the vein open-cut at one place to a depth of 40 feet and a length of 60 feet. The ore is hauled by wagon to the mill, crushed and jigged by hand. No work has been done in the old pits during the year.

Mr. M. J. Flynn is superintendent.

Feldspar

Richardson Mine

The Kingston Feldspar and Mining Company shipped steadily from their mine during 1909. During the winter of 1909-10 a considerable tonnage of quartz, which occurred as a capping over the feldspar in the central part of the pit, was removed and shipped to Welland, where it is used in the manufacture of ferro-silicon. The removal of the quartz will combine the workings into one large open pit, and make accessible a large tonnage of feldspar. The same system of mining and haulage as described in former Reports is used.

Talc

The only producing talc mine in Ontario is situated about one-half mile east of Madoc on lot 14, in the fourteenth concession of Huntingdon. The mine has been worked almost continuously for the last year, under the direction of Mr. S. Wellington. Operations in the open pit were suspended during the winter, and since that time the talc has been obtained from open cutting the deposit to the east of the old open cut. A new shaft to the west of the old workings has been sunk 140 feet and timbered.

Talc Mill

Geo. H. Gillespie and Company have built a mill for fine grinding talc near the Grand Trunk station at Madoc. The crude talc is obtained from the above mine. The capacity of the mill has been recently doubled, so that from 16 to 20 tons of finished talc are produced every twenty-four hours. Electric power is now used for driving the machinery, being obtained from the Seymour Power and Electric Company.

The ground talc is used largely in the paper trade.

Mica

Lacey Mine

The Loughborough Mining Company worked the Lacey mine continuously during the year. During the summer the open cut north of the air shaft was sunk to the first level of the mine. This open cut is about 75 feet long by 60 feet wide. During the winter the work was confined to the deposit south of the old workings and parallel to them. On this a drift has been run 200 feet, and a stope carried 35 feet in height. Some diamond drilling was also done here.

The Loughborough Mining Company also operated the Hanlan mine near Perth for part of the year, but it was closed down and abandoned late in 1909. The workings had been carried to a depth of 175 feet and for 200 feet in length.

Mr. G. W. McNaughton is manager for the company.

Tully

On lot 9 in the fifth concession of Burgess, Mr. Edward Smith has opened up a mica prospect. A number of test pits have been sunk on this property to depths varying from 5 feet to 40 feet, and a quantity of mica has been taken out.

The Silver Queen property on lot 13 in the same concession has been closed for about a year, owing to legal difficulties regarding the title.

Mica Prospects

On lot 1, in the eleventh concession of Loughborough, Mr. H. Richardson, of Kingston, has been developing a mica prospect. One pit has been sunk to a depth of 45 feet and stoped out for a length of 75 feet. Another pit was sunk to a depth of 50 feet.

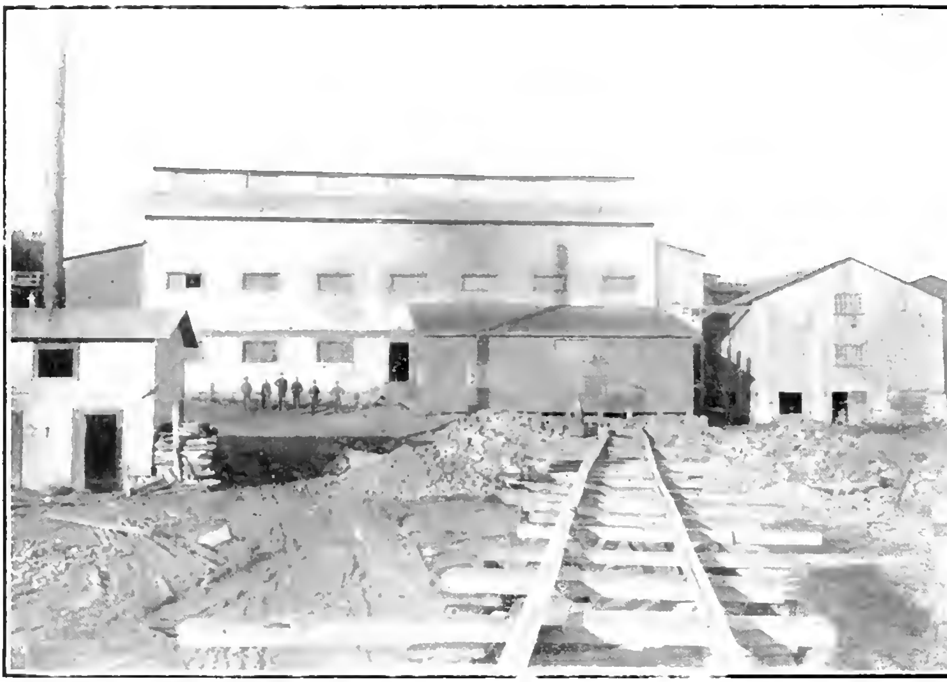
On the north part of lot 6, in the eighth concession of Loughborough, Messrs. Scriven and Whyte have been mining mica for some months. A shaft has been sunk to a depth of 45 feet, and about 25 feet of drifting done on the vein east and west from the shaft.

A small boiler and hoist have been installed.

Messrs. Stoness and Kent have worked part of the year on their property on the west side of Bob's lake.

On the Amey property on lot 7 in the ninth concession of Loughborough, some work was done early in 1910.

Mr. Rinaldo McConnell worked a mica property on the northwest side of Otty lake during the winter of 1909. The Kent Bros. of Kingston also did some development work near Otty lake.



Black Donald Graphite Company.

Mica Trimming Works

The following firms are engaged in trimming and thin splitting mica in Ottawa:—General Electric Company, Laurentide Mica Company, Eugene Munsell and Company, Wallingford Mining and Mica Company, Mr. R. Blackburn, Mr. S. O. Fillion, Mr. S. Holland; and in Kingston, Kent Bros.

Graphite

For a number of years there has been a small and irregular production of graphite in Ontario. During the last year the production of both flake graphite and amorphous has been steady, and the outlook for the graphite industry in Ontario is very favorable.

Black Donald

The Black Donald Graphite Company were operating the Black Donald mine near Whitefish lake during 1909. The mine was only worked about three months during the year, but the mill was run continuously. The mine was reopened in June, 1910. Graphite is mined during the summer months to keep the mill in operation during the whole year.

The mining work is being carried on in the open pit on the shore of the lake. This open pit is 80 feet deep and 175 feet in length. Stoping is being carried on, in the north

end of the pit, where the stope is being carried back under the coffer dam which was built some years ago to protect the workings.

Power for the mine and the mill is developed at the Madawaska river, two miles distant.

The graphite is concentrated and refined at the mill at the mine and shipped by wagon to Calabogie, 14 miles distant, for shipment to the consumers.

Mr. R. F. Bunting is manager and Mr. Geo. W. Stewart superintendent.

McConnell

Mining was carried on during the greater part of the year by the Globe Refining Company, near Port Elmsley.

The concentrating mill at Port Elmsley, three miles distant from the mine, was in operation and treated the ore from the mine. Some changes were made in the mill in the method of concentrating and refining the graphite.

At the mine the shaft was sunk to a depth of 50 feet and stoping carried on both east and west of the shaft for a distance of 75 feet in each direction. The ore is hoisted by skip, dumped into a pocket and hauled by wagon to the mine.

Mr. C. Meech is superintendent, employing a force of 30 men at the mine and mill.

Corundum

Manufacturers' Company

The Manufacturers' Corundum Company have operated under lease the mines and plant of the Canada Corundum Company during the year. The mill has been run full capacity on day shift.

The ore has been obtained from the hill near the mill on which all the corundum has formerly been obtained and from a pit known as the Klondike on the west end of the hill, about one mile from the mill. Here the ore is being quarried by open cut work and hauled in wagons to the mill. On the main hill four pits are being worked, these pits varying in depth from 10 to 35 feet.

No important change has been made in the system of concentration.

The ore is sold chiefly to the abrasive wheel and paper makers in the United States.

Mr. D. A. Brebner is manager, employing a force of 125 men.

Ashland Emery and Corundum Company

On lots 15 and 16 in the thirteenth concession of the township of Carlow the above company have been mining corundum-bearing rock and shipping it to their mill, about half a mile distant, for concentration. The corundum milled during the year has been mined from two open cuts. The largest of these two open cuts is about 150 feet in length, 40 feet in width and an average of 35 feet in depth. The other is about half the dimensions.

The same system of concentration is employed as was described in former Reports of the Bureau of Mines. The ore is crushed and sized, then passed over Wilfley tables, the heads from these tables being then further concentrated on Hooper air jigs. The iron is taken out by passing the concentrates over a magnetic separator.

Mr. W. Mackie is in charge of operations.

Feldspar

McDonald

On lots 4 and 5 in the tenth concession of Portland the McDonald Feldspar Mining Company have been engaged during the year in mining feldspar and quartz. On lot 4 an open cut has been made on the deposit for a length of 300 feet and a depth of 50 feet. On lot 5 the feldspar has been taken from an open cut 100 feet long, 50 feet wide and 20 feet deep. Both feldspar and quartz are being shipped, the former to East Liverpool and the latter to Welland.

Small boilers and hoists have been installed at both properties and hoisting done by derrick.

The properties are situated about two miles from the Kingston and Pembroke railway near Verona.

Mr. R. R. Gamey is president of the company and Mr. E. H. Snook superintendent, and about 40 men are employed.

Card Mine

On lot 16 in the eleventh concession of the township of Portland, about two miles west of Verona, the Kingston Feldspar and Mining Company have been engaged mining feldspar. This property was worked in 1905 and 1906 by the Kingston Mining and Development Company, and was purchased by the present owners in 1909 and has since been operated by them. The feldspar is mined by open cut work. This open cut is 200 feet long, 30 feet wide and 25 feet deep. The ore taken out has been stock-piled at the mine.

WATER POWERS FOR WORKING MINES

By E. T. CORKILL

The importance to the mining industry of this Province of the plentiful supply of water power found in northern Ontario has more than once been referred to in the Reports of the Bureau of Mines.[1] When a mine is opened in northern Ontario the fuel first employed is naturally wood, which is abundant over practically the whole of the territory, and which usually suffices for steam production during the earlier stages of development and operation. For the most part, however, the wood consists of jack pine, tamarac, balsam and the other smaller conifers, together with birch and poplar, which varieties are not well suited for fuel purposes, their lasting properties being poor; and if the workings are at all extensive the area of wooded territory tributary to the mine speedily becomes exhausted, and wood must be brought from so great a radius as to make it too expensive for use. If the mine is near a railway, coal is then resorted to, and in many of the mining camps in Ontario coal soon displaces wood. Cobalt was a notable example of this. Should mining operations give promise of permanency, resort is then had to water power, the initial expense of introducing which is usually considerable, but which in the end is much cheaper than steam power produced by the combustion of either wood or coal.

Fortunately, the essential condition for water power exists in every mining camp in the Province, namely, falling water sufficient in volume and descent to warrant the conversion of its energy into the electric current. This stage the mining industry has reached in several important fields. For instance, in the nickel-copper mines of the Sudbury region, both the chief producing companies now operate their mines and works by electricity generated by water power, the Canadian Copper Company at the High Falls of the Spanish river, and the Mond Nickel Company at Wabageshik Falls on the Vermilion. The steam plants formerly used by these companies are now simply kept in reserve, in case of accident or interruption of the electric power. The Michipicoten iron region is now likewise supplied with power from the High Falls of the Michipicoten, which hoists the ore and lights the workings of the Helen mine. The low-grade gold ores of the same region also share in this advantage.

During the last year several water powers have been undergoing development for use in the mines of Cobalt. Two of these are situated on the Montreal river, at Ragged Chutes and Hound Chute respectively, and one at the foot of Bass lake, on the Matabitchouan river, which stream empties into lake Temiskaming a few yards from the mouth of the Montreal.

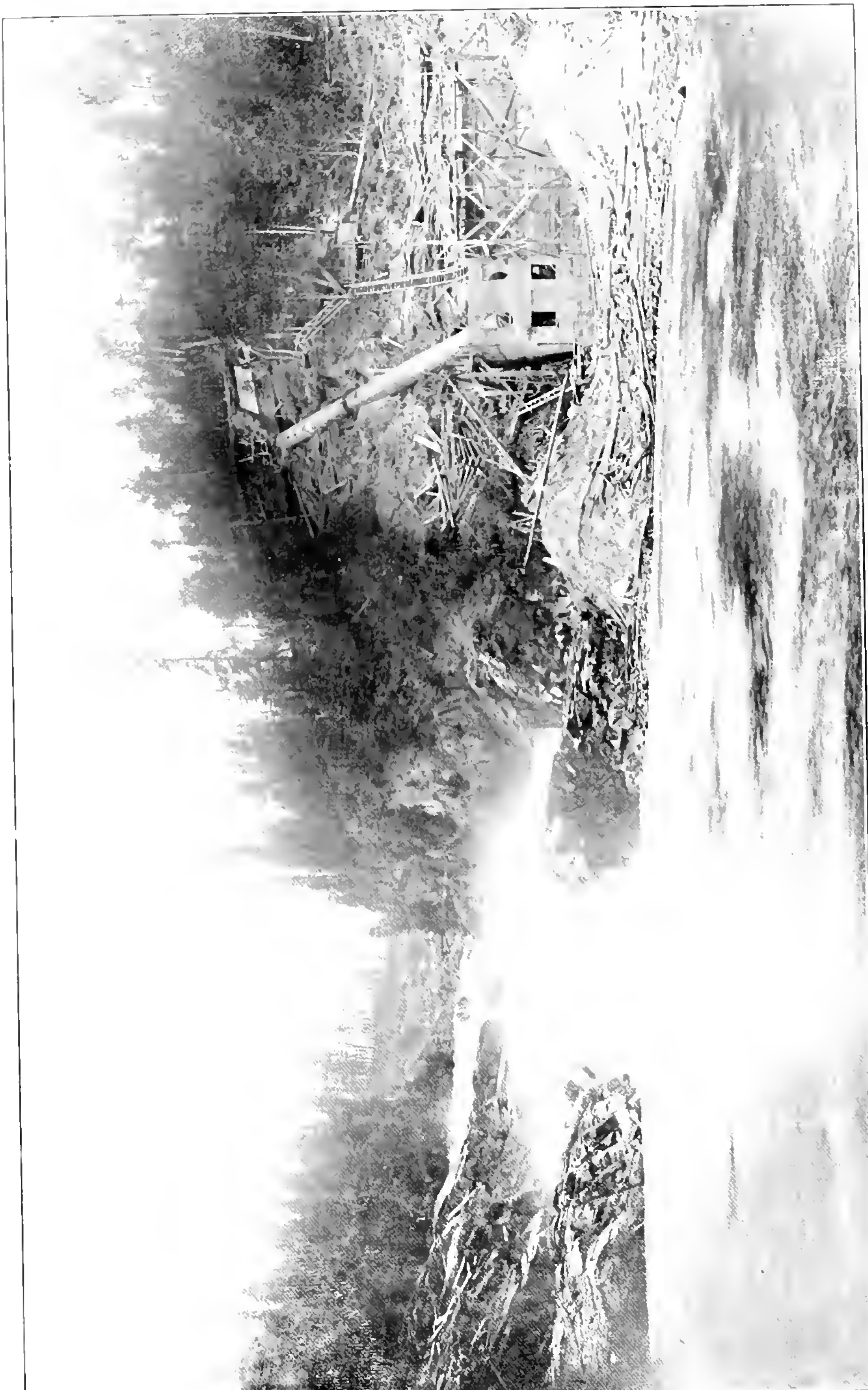
In eastern Ontario, water power developed on the Madawaska river is used at the Black Donald graphite mine in Brougham township, and more recently the energy from the surplus water on the Trent river at Campbellford has been conveyed by electric current to the reduction works of the Deloro Mining and Reduction Company at Deloro, and is now being taken to the mine and acid plant at Sulphide. If the new gold field of Porcupine proves to be permanently workable, there will be no difficulty in harnessing the falls on the Mattagami, Grassy and other rivers within convenient reach for use in the mines. The same is true with regard to the silver mines of Gowganda and the gold veins of Larder lake.

In Michipicoten District

Algoma Power Company

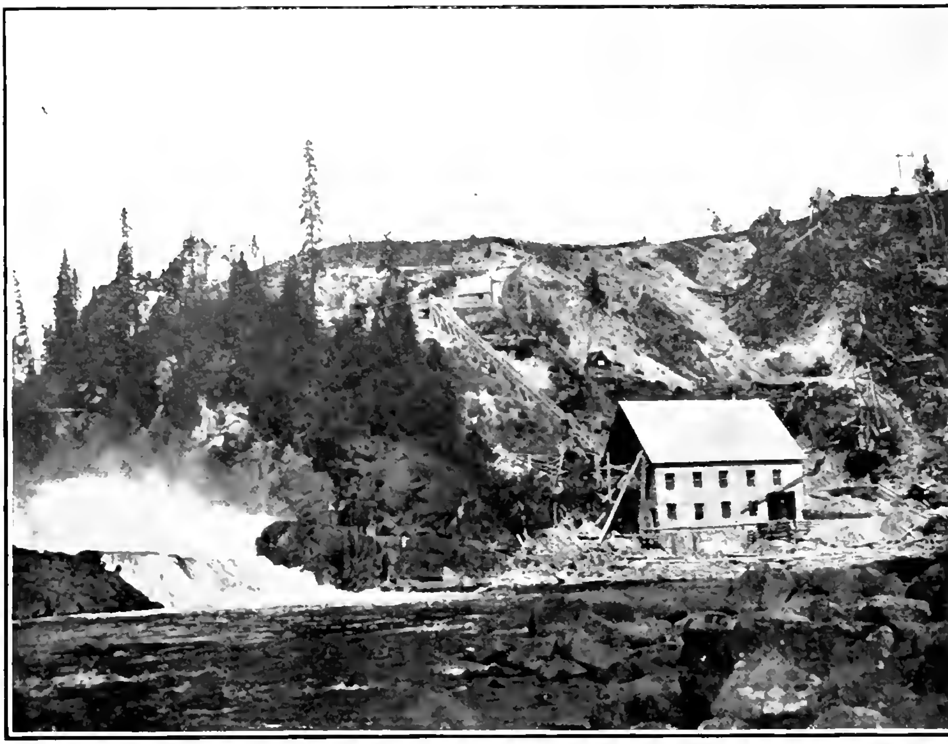
At High Falls, on the Michipicoten river, about 15 miles from Michipicoten harbor, on the north shore of lake Superior, the Algoma Power Company completed the installation of a power plant in 1907, and have since that time been supplying electric power to the mines in the Michipicoten area.

[1] See 7th Rep. Bur. Min., pp. 251-6; 14th do., p. 10; 15th do., pp. 13, 14, 62, etc.



Michipicoten Power Company. High falls, Michipicoten river, showing power house and penstock.

The effective head of water at the falls is 128 feet, giving a total amount of power capable of development of about 7,000-h.p. The bulk head is fitted with an opening for a 10-foot penstock, but only a 7-foot wooden penstock has yet been constructed. One unit consists of a horizontal turbine of 700-h.p., 600 r.p.m. direct coupled to a 450 k.w. generator. Another unit has been installed, consisting of a 1,000-h.p. turbine direct connected to a 600 k.w. generator. The three-phase current is stepped up from 2,200 volts to 10,000 volts, at which voltage it is delivered to the lines. The power house is built of concrete. The chief market for power is at the Helen iron mine. Three of the gold mines, namely, the Grace, Norwalk and Kitchegammi, have power lines to their plants, and have been using the power intermittently. Mr. D. B. Detweiler, of Berlin, is president of the company.



Power development at High Falls, Michipicoten river

In the Cobalt Silver Camp

Cobalt Hydraulic Power Company

The Cobalt Hydraulic Power Company has constructed the largest one-unit air compressor in the world at Ragged Chutes, on the Montreal river, about nine miles south of Cobalt. This plant operates on the Taylor system, whereby the air is compressed by the direct action of falling water. At Ragged Chutes there is a drop of 54 feet in the river in a distance of 1,000 feet. The whole head is utilized, and furnishes 5,500 horse power, which will compress 40,000 cubic feet of free air per minute at a pressure of 120 pounds per square inch. The air pressure is automatically reduced to 100 pounds per square inch when delivered to the various Cobalt mines, in order to insure a constant pressure regardless of any loss in the main transmission lines.

After passing through the gates the water flows through two 16-foot diameter intake heads. In each of these heads there are sixty-six 14-inch diameter pipes set in a steel disc. Below the pipes the heads gradually diminish in diameter until they become 8 feet $4\frac{3}{4}$ inches, and from this point they are 15 feet long. In this telescopic form the heads connect with the intake shafts, which are 8 feet 6 inches in diameter and 345 feet deep, with the orifice of the head at the surface of the water. This arrangement permits the heads to be raised or lowered, to conform to the level of the water in the forebay, or the heads may be raised above the level of the water by air lifts, thus cutting off the supply completely. The two air-lift cylinders act as governors, automatically raising and lowering the heads which are suspended from them by the hangers, thereby regulating the flow of water into the intake pipes, according to the demand. The head pieces were especially designed to meet conditions due to extremely low temperature. The gate is raised by rack and pinion, and there is the usual rack to prevent floating material from entering the head-pipes.

The water with the entrained air flows through the heads with a descending velocity of 15 to 19 feet per second, gradually diminishing in the velocity of fall, owing to the compression of the volume of air; finally, there is a further reduction in velocity owing to the enlarged section of the last 40 feet of fall. By the time the water reaches and strikes the steel-capped concrete diverting cones its velocity is so diminished by the baffle from the compressed air that there is little shock.

The cones are for the purpose of spreading the flow of air and water, thereby bringing the air nearer the surface as the water starts to flow through the tunnel. The density of the air being less than that of water, it rises to the surface of the latter under a pressure of 120 pounds per square inch. The tunnel was made 20 feet wide, 26 feet high and 1,000 feet long, for the purpose of utilizing the total head of the stream, although this length was not necessary in order to give the air time to leave the water before the latter starts up the outlet shaft. As the velocity of the water in the tunnel is about three feet per second, practically all the air will leave the water in the first 300 feet. The last 75 feet of the tunnel has the height reduced to 16 feet.

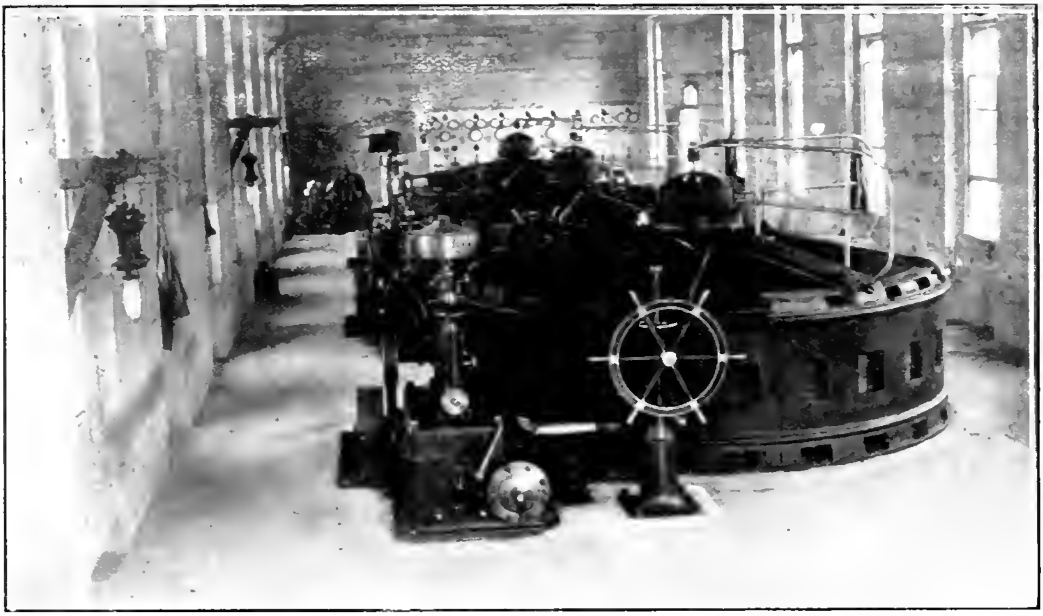
The pressure given to the air is due to the height of the body of the water in the outlet shaft, which in this case is 298 feet deep and 22 feet in diameter. The water flows along the tunnel and up the outlet to the river, the difference in elevation between the mouth of the intake and the discharge tunnels being 47 feet. Near the outlet end of the tunnel its height is increased to 42 feet, and at this place two pipes are carried through a 30-degree rise to the uptake shaft. One pipe, 24 inches in diameter, carries the compressed air to the surface, where it is connected with the 20-inch air main pipe line. The other pipe is 12 inches in diameter, and has its end submerged at a safe distance above the roof of the outlet portion of the tunnel, in order to act as a blow-off in case the air in the tunnel should acquire such pressure as to force the water below the level of the tunnel outlet. If the air were allowed to escape up the outlet it would lighten the column of water in that shaft, and the air pressure would not be constant. The blow-off pipe ends at the upper level of the water in the outlet shaft, its end remaining open to the atmosphere. When the volume of air is greater than the demand, the air accumulates in the upper part of the tunnel, forcing the water down and exposing the lower end of the blow-off pipe to the compressed air, thus allowing a portion of the water in this pipe to drop back, thereby decreasing the weight of the remaining water in this pipe to less than the pressure of the air. The equilibrium is now overcome, and the water in the pipe is driven upwards to the surface, where a most spectacular sight is witnessed, as a body of water is shot out by the air sometimes to a height of 500 feet. The blow-off continues until the pressure of the air in the tunnel is sufficiently reduced to again submerge the end of the pipe. Water now rises until an equilibrium is established between the air and water pressure in the tunnel. The air pipe and blow-off pipe are packed in concrete the entire length of the 30-degree raise, in order to seal them and prevent any escape of air up the outlet shaft. These arrangements permit the delivery of a large body of air at a constant pressure at all times.

Blow-off at Cobalt Hydraulic Power Company's plant on Montreal river.

The air is transmitted through nine miles of 20-inch diameter pipe, from the end of which there are two 12-inch diameter branch pipe lines. At a point about seven miles from the compressor there is another 12-inch diameter branch pipe line, so that the total length of 20-inch, 12-inch, 6-inch and 3-inch diameter pipes is about 21 miles.

Much care has been taken in the installation of the pipe lines to prevent leaky joints and strains on the pipe. In the 20-inch and 12-inch diameter pipe lines, balanced expansion joints have been placed at half-mile intervals, and half-way between each two expansion joints the pipes are anchored in massive concrete piers to prevent their creeping.

The compressed air is supplied by meter to the larger consumers for 25 cents per thousand cubic feet at 100 pounds pressure and atmospheric temperature.



Generators, governors and exciters, Cobalt Power Company.

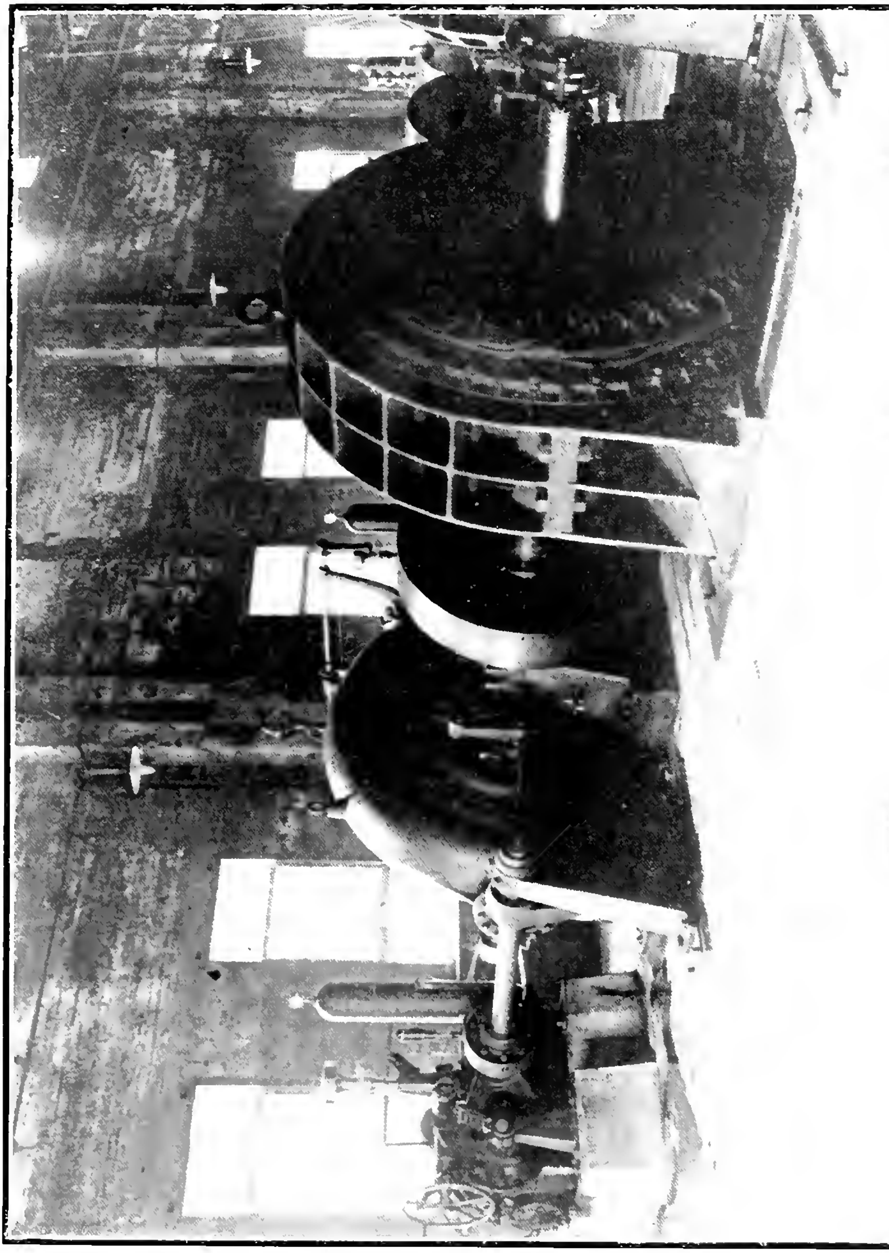
To the smaller consumers the following rates will be charged per drill per 10-hour shift:—

1 Drill	$5.00	each
2 Drills	4.00	"
3 "	3.50	"
4 "	3.10	"
5 "	2.83	"

At Ragged Chutes an electric power plant has been installed. The turbine is belted to a 400 k.w., 2,300 volt, 3-phase, 60-cycle generator. This power is sold to the Cobalt Power Company and distributed by them.

Cobalt Power Company

At Hound Chute, on the Montreal river, six miles below Gillies Depot and six miles south of Cobalt, the Cobalt Power Company completed, in May, 1910, a power plant for supplying electric power, chiefly to the mines at Cobalt. The effective head of water is 35 feet, and a dam 27 feet high at the head of the falls diverts the water into a new channel 1,400 feet in length leading to the power house at the bottom of the falls.



One of the four 1875 k.w., 3-phase, 2,400 volt generators with turbine and governor. Mines Power, Limited.

The power house is 132 feet long, 32 feet wide, and 82 feet high from the top of the walls to the bottom of the wheel pit, and is built of steel and concrete. The electric equipment consists of three 750-k.w. generators direct connected with three turbines of 1,465-h.p. each. There are two exciters, each direct connected to a turbine, one being held in reserve in case of accident.

The 3-phase current is stepped up to 10,000 volts for transmission, and will be stepped down to the voltage required by the consumer. The transmission line to Cobalt consists of two complete circuits on a single pole line.

The company supplies power either at a flat rate of approximately $50 per h.p. per annum, or on a meter basis.

Mines Power Limited

About June 1st, 1909, the Mines Power, Limited, began developing electric power on the Matabitchouan river, about two miles from the Montreal river landing, on lake Temiskaming, and 23½ miles southeast of Cobalt, and although the physical conditions as to transportation of apparatus and supplies were of a severe type, this company was enabled to complete the development and to make delivery of electric power in March, 1910.

At the point of development the Matabitchouan river makes a horseshoe sweep. The waters have been diverted, at one point of the horseshoe, through an intake canal and the penstocks to the power house, which is located at the other point of the horseshoe.

The main dam, which has been constructed at the curve of the horseshoe, is of solid concrete, with a length of 860 feet and a maximum height of 50 feet, which raises the water 10 feet above its former high level and gives a working head of 312 feet. Several lakes of various sizes have been utilized for storage purposes.

The power house, of solid concrete construction, has been designed for and is capable of developing 10,000-h.p. It is 57 feet by 105 feet, and is thoroughly equipped with travelling cranes and other appliances.

The two penstocks are 5 feet in diameter and 1,075 feet in length, each supplying water to a pair of turbines. The water is directed to the turbines by means of forged steel moveable guide vanes.

The turbines are of the horizontal reaction type, consisting of a single runner in spiral case, with a speed of 600-r.p.m., and rated at 2,750-b.h.p. each.

The electric equipment consists of four 1,875 k.w. A.E. generators direct connected to the turbines. Two exciters are installed, each being connected to a Nobel impulse wheel with a rating of 180-h.p., 475-r.p.m. Four 1,875-k.w., 3-phase transformers are used to increase the voltage to 44,000 volts. High-power governors have also been installed to insure perfect regulation.

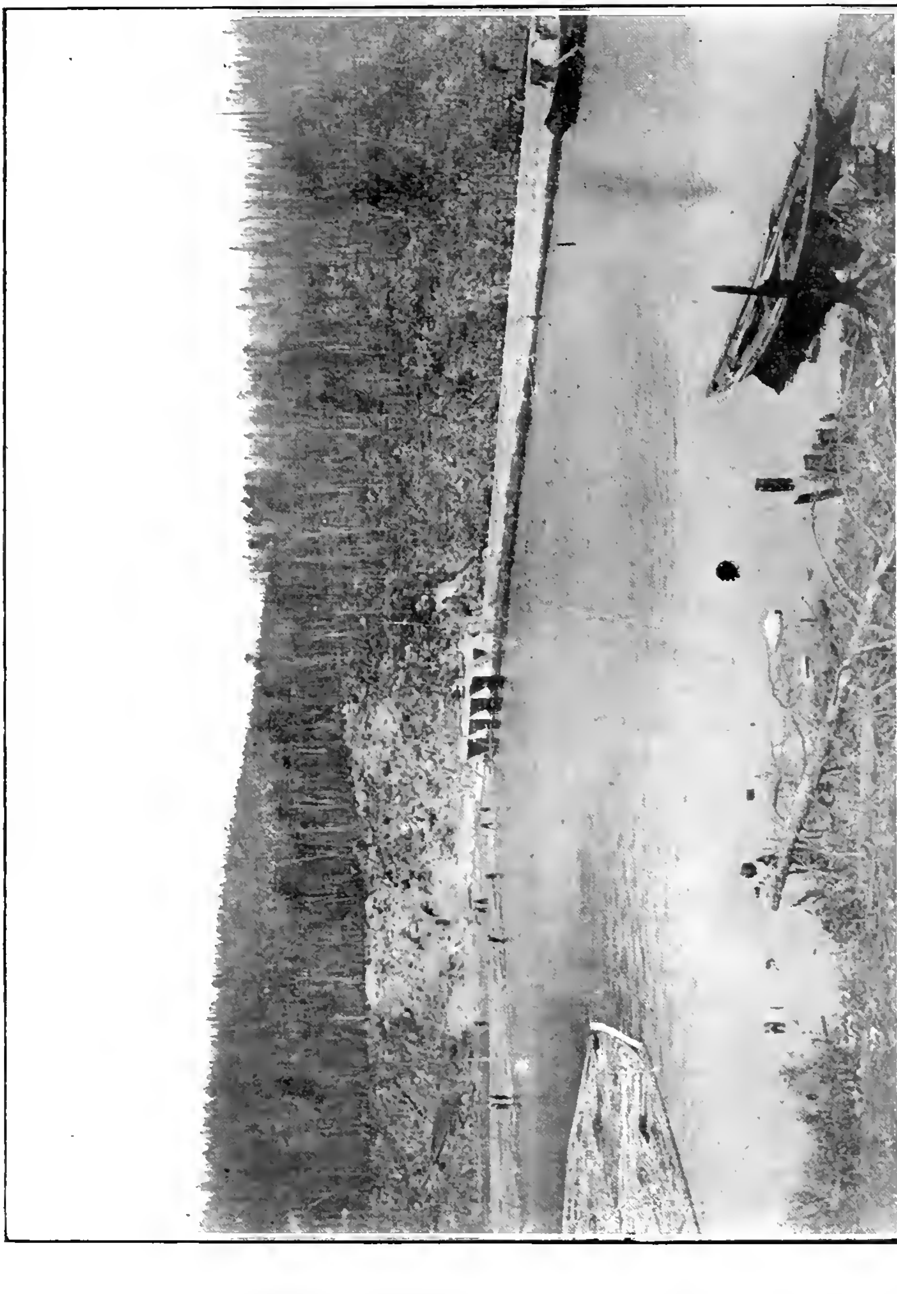
The two 25-mile transmission lines are both 3-phase, and are operated at 44,000 volts, each line having been erected on a separate set of poles 35 feet apart.

The overhead work is of substantial construction, and each line is of sufficient capacity to carry the entire load in the event of trouble developing.

Stranded aluminium cable has been used for conductors, and these are supported on high-tension porcelain insulators.

The 135-foot right-of-way has been cleared of all brush and trees, and all high trees on either side have been removed. Patrolmen are stationed at different points, and the entire line is inspected daily

Two sub-stations have been erected to serve the Cobalt camp, one at Cobalt lake, with a capacity of 5,500-h.p., and one at Brady lake, with a capacity of 3,200-h.p. Each station is equipped with the necessary step-down transformers, lightning arresters, switching devices, etc., and in each there have been installed two 2-stage air compressors. Each compressor is capable of developing 5,000 cubic feet of free air per minute, and is driven by 1,000-h.p. 2,200-volt induction motors. The compressors are of special



Upstream side of main concrete dam. Mines Power, Limited.

design, having been constructed under a guarantee requiring the delivery of air at mines at 100-lb. pressure and at approximately atmospheric temperature and free from moisture.

The sub-stations have been connected by both air lines and 2,200-volt electric lines, to guard against shut-downs due to sub-station troubles.

The electric distribution to the various properties is 3-phase, 60-cycle, 2,200-volt, thus obviating the necessity of maintaining high voltage sub-stations on customers' premises.

For the supply of current for small units and for lighting purposes, 550-volt and 110-volt line transformers are used.

The electric service is being used to operate the lines of the Nipissing Central railway. Alternating current is delivered in the form of 3-phase, 2,200 volt, and is converted to 550-volt direct current by means of motor generator sets in the railway's sub-stations.

The Cobalt Light, Power and Water Company are supplied with current for illuminating and other purposes in Cobalt.

The selling rates are as follows:—

Compressed air, 24 cents per 1,000 cubic feet, at 100-lb. pressure.

Electric service, approximately $50.00 per h.p. per annum for 24-hour service.

The high-tension transmission lines are erected through South Lorrain. To meet the market a substation of 1,500-h.p. capacity is being erected at Beaver lake, and one of 500-h.p. capacity at Latour lake.

The president of the company is Mr. E. A. Wallberg, of Montreal, and the general manager Mr. F. John Bell, of Cobalt.

In the Sudbury Nickel Field

Huronian Power Company

This is a subsidiary company of the Canadian Copper Company, formed for developing electric power for use at the mines and smelter of the Canadian Copper Company. The site is at High Falls on the Spanish river, in the township of Hyman, about four miles from the "Soo" line of the Canadian Pacific railway, at a point about 23 miles west of Copper Cliff station. It is connected with the railway by a spur line from Turbine station.

Work was begun on this spur line in the spring of 1904, and on the power development proper in the following September. Power was turned on at Copper Cliff in February, 1906. The power house is situated on the lower point of an island in the river, across which the water is carried. The natural head was 67 feet, which has been raised by the dams to 85 feet. The effective water-shed is upwards of 2,000 square miles, practically all improved, containing much lake surface.

The dams are all of concrete construction on solid rock. The work of construction was carried on continuously throughout the winter of 1904-05.

Log slides and booms had to be provided, to handle the very large cut of timber which is annually driven down the Spanish river.

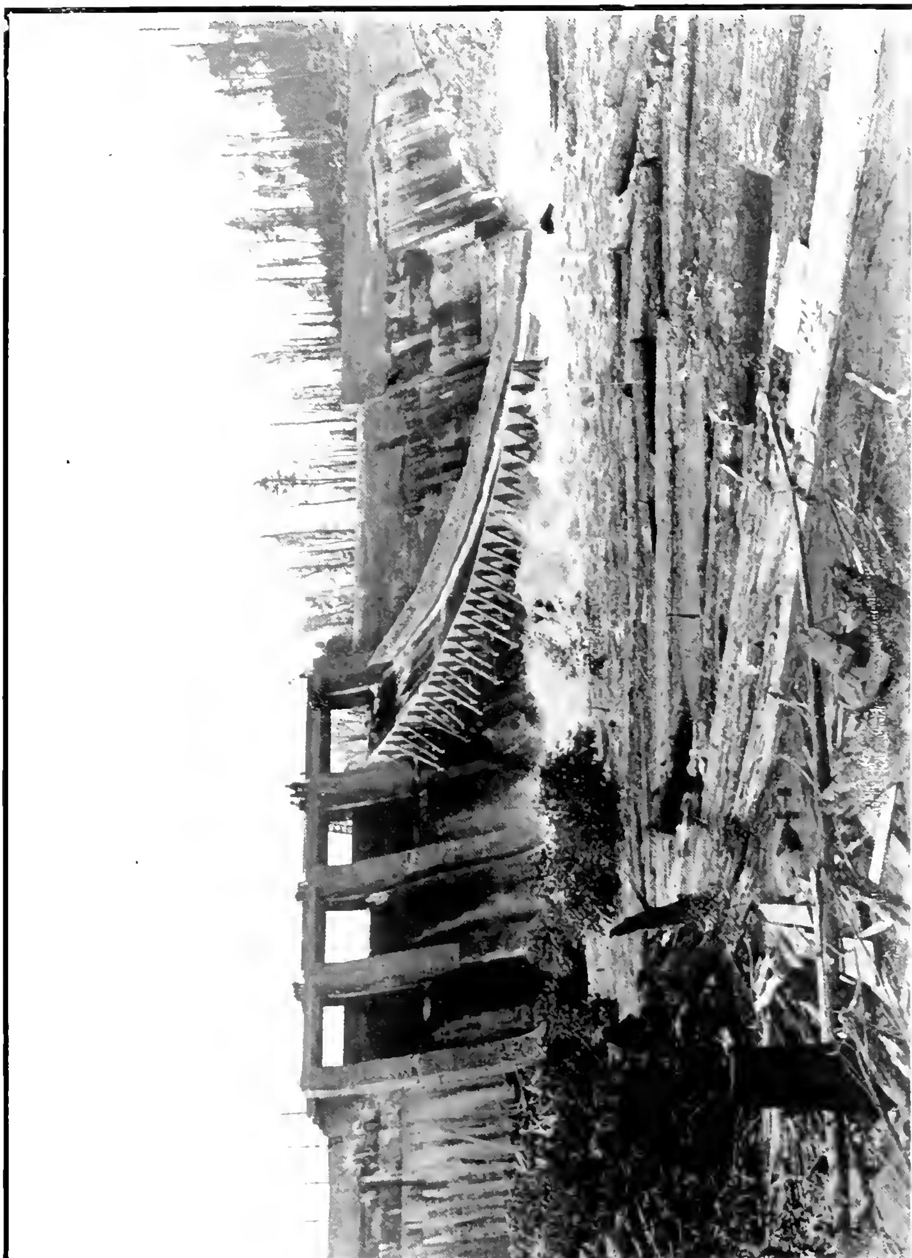
From the bulkhead wall three9-feet steel penstocks for generators, and one 3-feet for the exciters, are carried down the slope to the power house.

The power house is of brick on a concrete substructure, with steel roof trusses.

The roof covering is 2 x 4-inch lumber on edge, sheeted with galvanized iron. The building is 106 feet long by 71 feet wide, with an annex 33 x 30-feet at one end for workshop and heating boiler. The blower system of heating is used.

The generator room is 55 feet wide, leaving 16 feet along one side for transformer rooms and switch tower, which are separated from it by fireproof brick walls and steel doors.

There is space for four generating units, three of which are installed. Each unit consists of a 2,000-k.w. generator, 3-phase, 25-cycle, 2,400-volt, direct connected to the shaft of a 3,550-h.p. turbine, on which are mounted two 34-inch bronze runners in a single case.



Down-stream side of main concrete dam, showing log slide. Mines Power, Limited.

The head is 85 feet and the speed 375-r.p.m.

There are two exciters of 200-k.w. each, either of which can furnish excitation for four generators. Each exciter is driven by a small turbine, direct connected.

Three sets of transformers, of three each, step up the voltage from 2,400 to 35,000, at which it is transmitted.

The operators' bench board occupies a central elevated position in front of the switch tower, giving a full view of the generator room and the switching operations in the tower. All switches are distantly controlled, and there is nothing higher than 125 volts on the board.

A small motor-driven air compressor is installed for cleaning purposes and for handling oil by air pressure.

For fire protection there is a 500-gallon, 2-stage turbine pump, direct connected to a 50-horse-power d.c. motor, operated from the exciter. The pump suction is connected to the penstocks.

The penstocks, bulkhead gates and screens are housed, and the use of a small amount of current at critical points effectively prevents the building up of ice in the tubes.

The main transmission line is about 30 miles long, from the power house at High Falls to the substation at Copper Cliff, for the most part on its own right of way, 100 feet wide, all cleared. It is of double cedar pole construction, with poles at eight feet centres, bolted to a common cross-arm.

There are two independent 3-phase circuits of No. 1 wire, arranged in two equilateral triangles, 4 feet apart and 4 feet to a side. One circuit is transposed and the other straight. The pole stands are placed 120 feet apart.

Branch lines of single pole, single circuit construction, run from the main line to Crean Hill mine and Creighton mine, each being about 3½ miles in length. These are both connected to the same main circuit with aerial switches.

Lightning arresters, of the horn type, are provided outside of the power house and the sub-station at Copper Cliff, Creighton and Crean Hill.

A telephone line runs direct between the switchboards in the power house and smelter sub-station, along the transmission line. It is carried on a short cross-arm, 6 feet below the main cross-arm, with the wires transposed every fifth pole. It gives good service.

A second telephone line, carried for the most part on the poles of the Canadian Pacific railway's telegraph, connects the terminal stations with the Copper Cliff central station, and also with Crean Hill and other points between.

Lorne Power Company

The Lorne Power Company's plant is located at Wabageshik falls, Vermilion river, about 3½ miles from Nairn Station on the "Soo" branch of the Canadian Pacific railway, and 9 miles in a southwesterly direction from the Mond Nickel Company's smelter at Victoria Mines. This company is a subsidiary company of the Mond Nickel Company, and was formed for developing electric power and supplying it to that company for use at its mines and smelters.

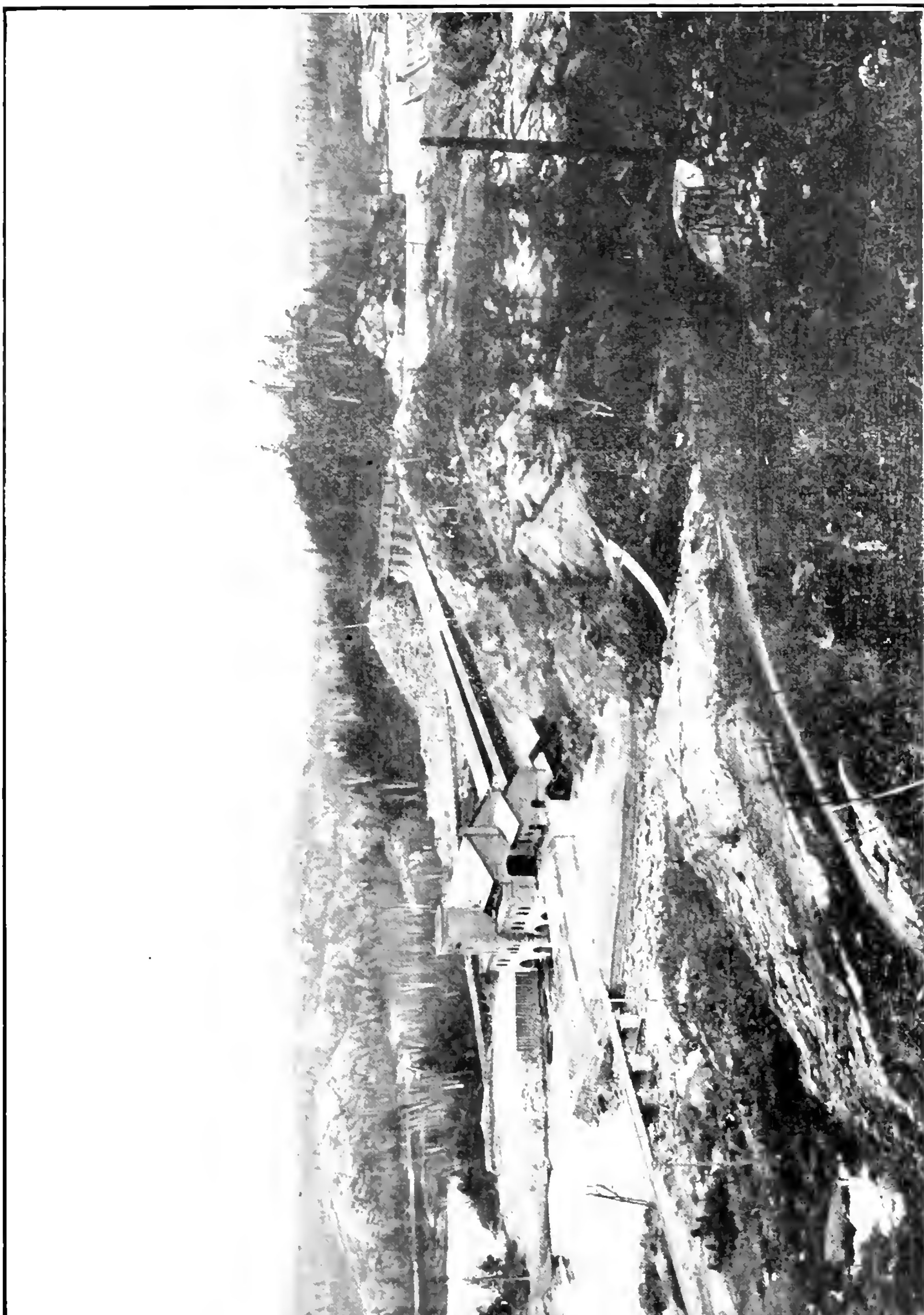
The plant has been in operation one year and has given good service.

The main dam, forebay and power house were built of concrete on rock, and are of heavy design and permanent construction.

One unit was installed at first, but provision was made for a second unit, which is now being installed.

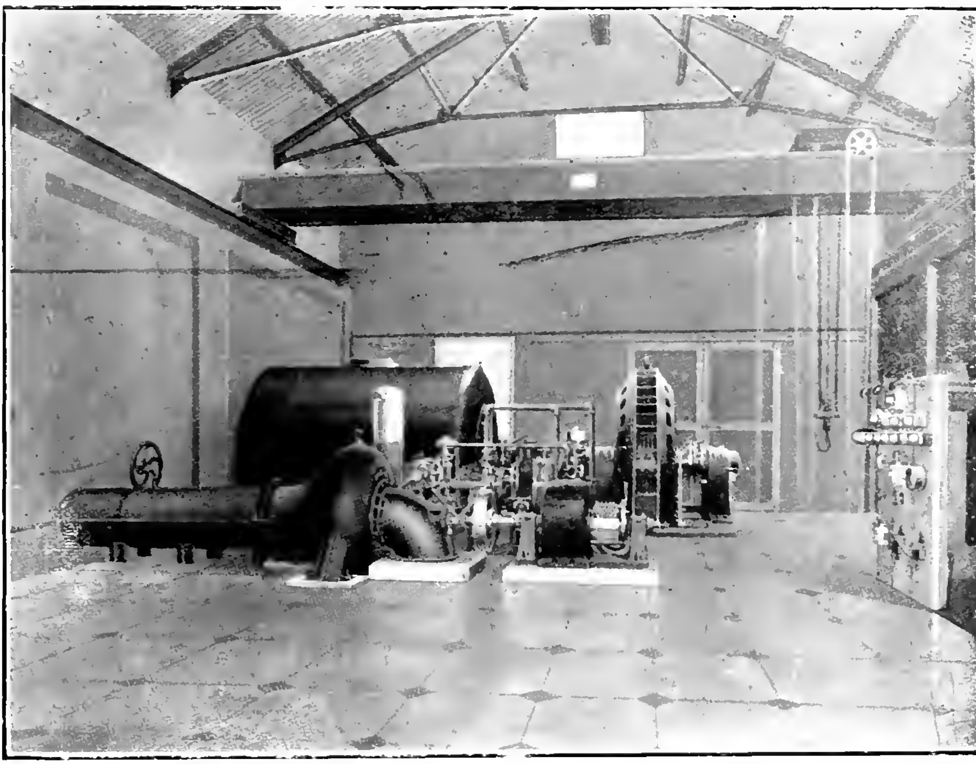
The penstocks are 450 feet in length and 8 feet in diameter. They are provided with two expansion joints each and are supported on concrete piers. Steel head gates are provided, and stop-log checks have been constructed in the forebay with a 12-inch drain pipe to provide for examination of the head gates if this becomes necessary.

Each unit consists of a horizontal twin turbine 2,200-h.p., 300 r.p.m. built to operate under 50 feet head; direct coupled alternator, 1,500-k.w. (or 1,200-k.w. at



General view of main dam, forebay, penstock (partly covered) and power house, Wabageshik.

80 per cent. power factor) 60-cycle; exciter turbine 110-h.p., 875 r.p.m.; exciter generator, 60-k.w. 120 volts; Allis-Chalmers Company oil governor for both main and exciter turbines. The exciter turbine penstocks are branched from the main penstocks, and are being coupled together in such a manner that either exciter turbine may be operated from either main penstock. Similarly either exciter may be used with either alternator. The 3-phase current is stepped up from 2,200 volts through three 800-k.w. transformers and delivered to the lines at 16,500 volts. The plant is provided with a 10-ton crane and the usual switchboards and other apparatus. It is protected by two sets of lightning arresters, and has so far not been interfered with by electric storm.



Interior view Lorne Power Company's plant, Wabageshik.

Sudbury Power Company

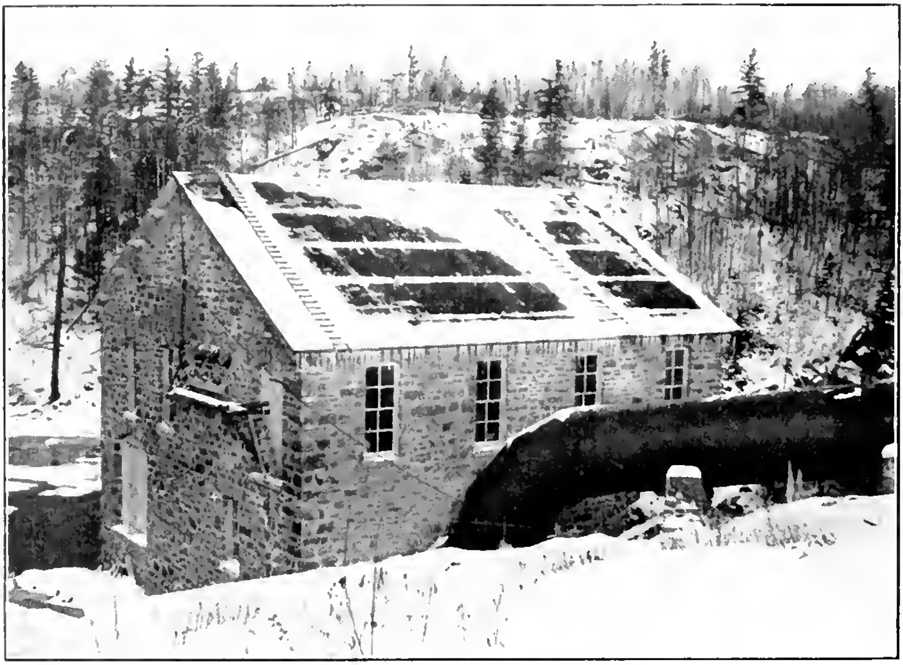
At McPherson's falls on the Vermilion river, on lot 11, concessions 1 and 2, Creighton township, about 16 miles west of Sudbury, the Sudbury Power Company have developed a water power. The natural head of the water power at the falls is 17 feet and the artificial head 24 feet. The power house is built of stone, and the dam of timber filled in with stone. A 1,000-k.w. generator manufactured by the Allis-Chalmers-Bullock company has been installed. The voltage is raised by transformer to 22,000 volts before being transmitted. The generator is coupled direct to four horizontal water wheels of the Samson Leffel pattern. There are also two 75 k.w. exciters, each driven by a separate pair of wheels and each pair of wheels is coupled direct in its own flume. The tail races are 12 by 20 feet in section, and are cut out of the solid rock.

Wahnapitae Power Company

On the Wahnapitae river, about nine miles southeast of Sudbury, the Wahnapitae Power Company completed the development of a water power in 1905. The power plant is situated about 18 miles from the lake of the same name, which has an area of 120 square miles.

The dam above the power house is built of timbers bolted to the rock and to each other, with interstices between the timber filled in with rock. It has a height of 35 feet, and a width of 200 to 250 feet.

The forebay, which is south of the dam, is 300 feet in length and its walls are of stone and cement. The dam at the end of the forebay is 25 feet in height, 15 feet thick at the bottom and about 6 feet at the top. The penstock from the forebay to the power house is 10 feet in diameter and 163 feet long. Three additional openings are left in the dam for increasing the capacity of the plant, which would then have a total capacity of 5,000 to 6,000 horse power.



Power House, Wahnapitae Power Company.

The total height of the fall is 56 feet. The tail race is 20 to 25 feet deep and 22 feet wide, cut out of solid rock. The turbine, manufactured by the Jenckes Machine Company, of 1,600-h.p. capacity, is direct connected with an alternating current, 60-cycle generator, which develops 800-k.w., or about 1,200-h.p. The two transformers raise the voltage from 2,300 to 23,500 volts for transmission over the line. Power is at present being transmitted to Sudbury, a distance of 9 miles, by triple-phase transmission wire (No. 4). A transformer at Sudbury reduces the voltage to 110 or thereabouts for lighting purposes. Another unit was installed in 1909.

The company are also supplying the Garson mine with 800 horse power, and a transmission line is being erected to the Moose Mountain iron mine, which will use electric power when the installation is completed.

In Eastern Ontario

Black Donald Graphite Company

A small power was developed at Mountain Chute on the Madawaska river in 1901 for use at the Black Donald graphite mine, about two miles distant. The full power if developed would have an estimated low water flow of 790 c.f.s. under a 40-foot head and a minimum 24-hour power of 2,860-h.p. The company in installing the plant made use of a lumber company's dam and log chute, the flume being built in the rocky side of the river 90 feet in length by 20 feet wide and 12 feet high. The outside cribbing extends into the middle of the chute, with a penstock at the end, giving 22 feet head of water. The flume and penstock were rebuilt in 1908, the old wooden flume having been carried away by the high water. The new flume was cut in the solid rock at the side of the falls. The power house contains four 30-inch water wheels of a total capacity of 600-h.p. on one horizontal shaft direct connected to a 350-k.w. generator. The 3-phase alternating current is transmitted over a line two miles in length to the mine, where it is used to drive all the machinery.

The Seymour Power and Electric Company

The power station of the Seymour Power and Electric Company is located near the Government dam No. 1, section 5, on the Trent Valley canal, one mile above Campbellford, where an operating head of 23 feet is available. The power plant, when all the machinery is installed, will have a rated capacity of 3,000 k.w. Two machines are at present installed, having a capacity of 1,500 k.w.

The average discharge of the river is estimated at 4,742 cubic feet per second.

Dam No. 1, section 5, of the Trent Valley canal was built across the river by the Dominion Government. The locks are on one side of the river, and on the other side the Power Company have built the headworks for the intake canal, which conveys the water to the generating station, about 1,200 feet below, and near the shore line.

The substructure of the generating station is composed of concrete and the superstructure of concrete blocks. The equipment consists of two 750-k.w., 3-phase, 60-cycle, 2,400-volt., 150-r.p.m., vertical type generators manufactured by the Canadian General Electric Company. When completed, it will consist of five 750-k.w. generating units.

The generators are direct connected to vertical turbines of the double-runner central discharge type, having a maximum capacity of 1,100-h.p., under 23 feet, at 150 r.p.m. The revolving parts of the two units are supported by an oil lubricated thrust bearing of the cast-iron disc, spherical seat type, on a concrete and steel thrust deck erected between the generator and the turbine. The generating units are located in line on the upstream side of the building, the transformers in pockets on the downstream side and the main switchboard between the generators and the transformers. The transformers have a normal capacity of 1,125 k.w., and will operate 2,400 volts to 44,000 volts.

The switchboard consists of 15 slate panels. Each generator panel is equipped with an A.C. ammeter, an indicating wattmeter, a power factor meter, a D.C. field ammeter, a double throw field switch, a hand wheel for operating field rheostats, a switch lever for operating the generator oil switch, voltmeter and synchronizer plug receptacles.

At present there are two compound wound exciters rated C.Q. 15-17½-1,200, 115-125 volts. The exciters are belt connected to the generators.

The power lines entering the power house are equipped with lightning arresters of aluminium cell type.

The generating room, 26½ feet wide by 107 feet 4 inches long, is spanned with a 15-ton electric travelling crane.

The transmission wires are supported on wooden poles spaced 132 feet apart.

The conductors are of stranded hand-drawn aluminium. The aluminium used is manufactured at Shawinigan Falls, Quebec. The specification called for a conductivity

of at least 61 per cent. according to Matthiessen's standard, or ultimate strength of at least 25,000 lbs. per square inch, an elastic limit of not less than 14,000 lbs. per square inch and a modulus of elasticity of 9,000,000.

One sub-station is situated at Deloro, 22 miles from the power house. This consists of three 250-k.w. single-phase, oil insulated, self-cooled Westinghouse transformers, delta connected. The primaries are wound for 44,000 volts and the secondaries for 600 volts.

Another sub-station is located at Madoc to supply the town and the talc mill.

Belleville sub-station supplies the Trenton Electric and Water Company with power and light for Belleville.

Sub-stations have also been erected at Sulphide, where 300-400 h.p. is supplied, and at the town of Sterling, which is equipped with a 100-k.w. transformer for supplying light to the town. The Northumberland Pulp Company at Campbellford will take 800 h.p.

The engineers who have charge of the construction work are the firm of Smith, Kerry and Chase, of Toronto, to whom I am indebted for the details of this description.

THE KENT GAS FIELD

By G R Mickle, Mine Assessor.

The most interesting and important event in connection with the development of the natural gas industry in Ontario in recent years is the discovery and delimitation of this field, covering portions of the townships of Romney, East Tilbury and Raleigh. The accompanying sketch shows the field forming roughly a triangle with the base resting on the lake.

Where and How the Gas is Found

Drilling operations commenced in what is marked as "Oil Territory" on the plan in the year 1905, and the operations were pushed southwards. In December, 1906, the first well was drilled in the area near the lake, which has since proved to be productive of the wells of greatest capacity. Operations continued throughout 1907 and 1908, and by May of 1909 the limits of the field could be determined with some exactness so far as the land area is concerned. The gas-bearing rock, without doubt, however, extends some distance under the lake, and the wells of largest capacity are found not far from the lake shore.

The gas exists in the Onondaga formation (Jour. Can. Min. Inst., Vol. X., p. 82) in a dolomite rock. Usually four pay streaks are present. Thus, in three wells, which may be taken as typical of the southern or most productive part of the field, the levels at which "gas pay" was found were as follows:—

(1)	First gas found at	1,120	ft. depth.
	Second " " "	1,210	"
	Third " " "	1,305	"
	Fourth " " "	1,345	"
(2)	First gas found at	1,145	"
	Second " " "	1,240	"
	Third " " "	1,355	"
	Fourth " " "	1,380	"
(3)	First gas found at	1,145	"
	Second " " "	1,305	"
	Third " " "	1,375	"
	Bottom of hole	1,380	"

The Probable Supply of Gas

The capacity of the wells in this field is much greater than is usual in Ontario. Thus the "open flow" measurement of the wells in the Haldimand field, near Selkirk, which has not been drawn upon for long and is therefore near its maximum, averages less than 200,000 cubic feet in 24 hours. Only about 4 per cent. of the wells show a measurement of 500,000 feet or over. In the Kent field, on the other hand, a number of wells have an open flow capacity up to 7,000,000 feet, and the average of 17 wells known to the writer is about two and a half million feet.

At the present time the gas is piped to the following towns or cities, besides supplying farm houses along the lines, viz.: Chatham, about 14 miles; Windsor, about 45 miles; Sarnia, 55 miles; Blenheim, 14 miles; Ridgetown, 23 miles; Tilbury, Merlin and several other smaller places on the way to Windsor and Sarnia. In all, something like a population of 50,000 people is served by natural gas from this field.

The Factors of Supply

The question naturally arises, How much gas will be produced here? The quantity of gas depends on four factors, viz.:

(1) The area over which the gas-bearing rock is found.

(2) The average aggregate thickness of gas-bearing rock.

(3) The rock pressure.

(4) The amount of pore space in the rock.

With regard to the area, as the field is fairly well delimited, and practically no dry holes are found, this can be calculated. In measuring this, as all the evidence points to the gas-bearing rock extending some distance under the lake, a line was drawn parallel to the shore line one mile out in the lake and this was included in the gas area shown on plan. A planimeter was then used to measure the area. It proved to be 34.6 square miles. The chances are greatly in favor of the field extending further than this under the lake, and later on when the pressure drops, as the supply of gas diminishes, this gas will find its way in, as it is inconceivable that there could be a pressure of say 50 lb. or less on the land area, and 600 lb. in the same strata of rock under the lake. The figure arrived at below, therefore, is probably too small. It cannot be too large.

The second factor, the average thickness of gas-bearing rock, can be approximated by observations taken in drilling, and noting by measurements of the flow of gas from time to time how much this increases as the hole advances. Thus a layer of gas-bearing rock will be struck and the flow measured every foot, say, till the measurement is constant. There will then be no further increase of the flow till another pay streak is struck. The aggregate thickness of these layers has been taken as 10 feet, which is a safe estimate given by drillers.

The third factor, the rock pressure, is measured direct by a pressure gauge. The conventional way is to open the well if closed before, or close it if open, for five minutes, and take the reading at the end of five minutes. It is evident that this is a severe test when applied, as it will be later on, to a calculation of the amount of gas which has flowed from the field between certain periods of time. The rock pressure is about 600 lb. per square inch (a trifle less as a rule), or about 40 atmospheres. As a cubic foot of gas means a cubic foot at normal atmospheric pressure, and the volume occupied by gas varies inversely as the pressure—i.e., double the pressure expressed in atmospheres and the volume is decreased one-half—it is plain that when the pressure on the gas is reduced, as it always is before using, to about the normal atmospheric rate, the gas will occupy forty times the space it did in the rock. So that the insignificant pore spaces in the rock, very often so small that they cannot be seen by the naked eye, are capable of storing a large amount of gas.

The amount of pore space in the rock is the only factor in the calculation which cannot be measured directly or approximated in any way. From observations in other fields, however, it is calculated that the pore space runs generally from 4 to 16 per cent. of the total volume of the rock. Taking 10 per cent. as the mean, with the area, thickness and rock pressure mentioned above, we arrive at about 38,000 million cubic feet as the total probable output of the field.

This calculation admittedly depends on one thing which cannot be measured directly, but an independent check can be applied by an observation of the difference in rock pressure at two periods of times sufficiently far apart, and noting at the same time the amount of gas which has been produced. Thus from January, 1908, to May, 1909, inclusive, the total amount of gas produced from this field, including the waste, was about 1,810 million feet; this is 4.8 per cent. of the total supply calculated above, whereas the actual drop in the rock pressure, which is a definite accurate measure of the loss of volume, is only about 3.0 per cent. It is not possible with any other mineral product to make a calculation of this nature. We must, then, conclude that either the area or the pore space or the thickness has been assumed as too small. Applying this correction gives about 61,000 million feet as the probable output. This, as emphasized before, cannot be too large and probably is too small, as any extension of the gas-bearing rock under the lake could not show its effect on the pressure till a considerable reduction of the gas supply, and consequently in the pressure, takes place. The amount given, about 61,000 million feet, is the *minimum* possible supply. The length of gas-bearing rock measured along the lake shore is 8 miles; an extension of

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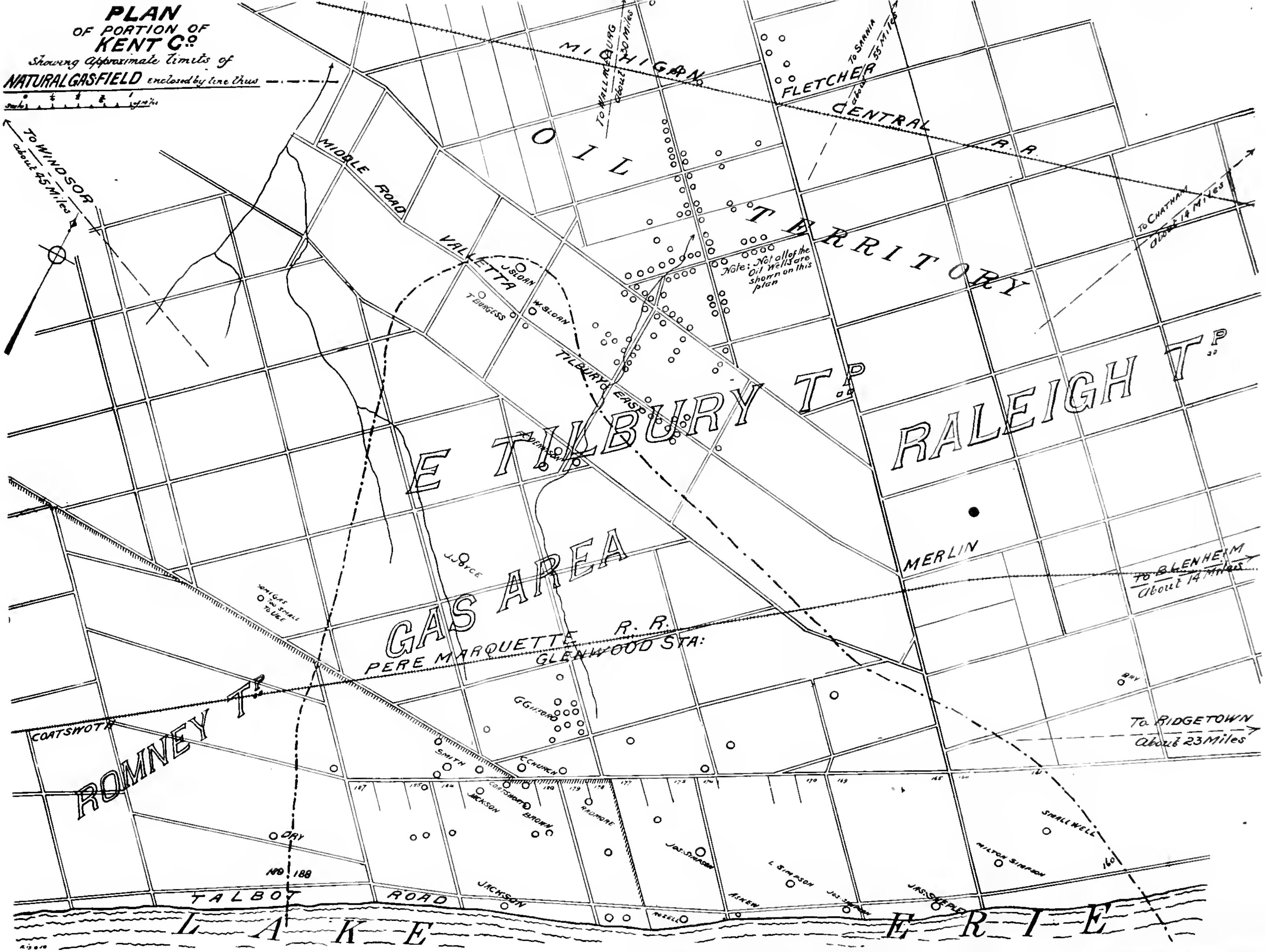

PLAN
OF PORTION OF
KENT Co.
Showing approximate limits of
NATURAL GAS FIELD enclosed by line thus
To WINDSOR
about 45 Miles
MIDDLE ROAD
VALLETTA
To WALLACEBURG
about 30 Miles
MICHIGAN
CENTRAL
R. R.
To SARNIA
about 55 Miles
FLETCHER
OIL TERRITORY
To CHATHAM
about 14 Miles
Note: Not all of the Oil wells are shown on this plan
J. SLOAN
W. SLOAN
T. BURGESS
TILBURY EAST
E TILBURY T.P
RALEIGH T.P
GAS AREA
MERLIN
To BLENHEIM
About 14 Miles
J. JOYCE
PERE MARQUETTE R. R.
GLENWOOD STA:
G. GIFFORD
To RIDGETOWN
About 23 Miles
COATSWOTH
ROMNEY T.P
SMITH
C. CHURCH
JACKSON
BROWN
RADMORE
DRY
No 188
JOS. SIMPSON
L. SIMPSON
ASKEW
MILTON SIMPSON
SMALL WELL
JAS. SHEPLEY
TALBOT ROAD
JACKSON
LAKE ERIE

that two miles more out into the lake—and there is no reason why it should not go ten miles—would increase the area by about 16 square miles, or about 50 per cent., and would probably increase the gas supply by the same amount. For the *probable* amount 70,000 million feet would doubtless be nearer an intelligent estimate than 61,000 million

How Long will the Supply Last?

The interesting question of how long this supply of gas will last is more difficult to determine, as it depends on the uncertain action of individuals animated by a variety of purposes, and not on any of the laws of nature. It will depend mainly on how well the gas is conserved; this in its turn is governed by legislation, and the manner in which the law is enforced. The greatest danger threatening the natural gas supply is the action of those drilling for oil. As mentioned in explanation of the operations of the Supplementary Revenue Act in 1909 elsewhere in this Report, the gas area and the oil territory in the county of Kent are closely connected. The oil if obtained can be sold at once, whereas to sell the gas, long expensive pipe lines must be laid, franchises obtained from towns and cities and then so much gas only can be sold each year. Moreover, the great expense of pipe line, increasing as the distance to which it is to be transported increases, prohibits taking the gas far to market. The individual interested in oil will, unless restrained, undoubtedly in the future as in the past sacrifice gas recklessly to secure a trifling amount of oil.

The use of natural gas for certain industrial purposes, e.g., as a substitute for coal under ordinary boilers to make steam, will tend of course to shorten the life of the field. Assuming that it was used only for domestic purposes, i.e., cooking, heating and lighting, the supply ought to last the 50,000 people who are now connected with the field thirty-three years at least, with a strong probability that it will exceed that period of time considerably.

The above calculation allows one million cubic feet per day throughout the year for each 10,000 of population. This is a liberal allowance. The city of Toronto, using artificial gas in many houses for cooking and heating and also for lighting, and to some extent for industrial purposes, with a population of 350,000, say, consumes about seven million feet per day all the year round, or 200,000 feet per day for each 10,000 inhabitants. This artificial gas is not equal to natural gas in heating efficiency, which varies according to the mode of manufacture; the kind supplied in Toronto is equivalent to only about two-thirds the same amount of natural gas. Thus, the efficiency of Toronto gas is 651.8 British thermal units per cubic foot (Dr. Ellis' report on System of Lighting for Toronto, 1900), whereas the natural gas has an efficiency of about 1,000 B.T.U. (Poole, Calorific Power of Fuels). The town of Galt, with about 10,000 people and approximately 1,800 meters in use, the gas being consumed for cooking, lighting, and to some extent for heating, consumes about 280,000 feet per day (statement from Dominion Natural Gas Company). The best example is probably Chatham, which takes its supply of gas from this field. The average consumption per day for domestic purposes, as shown by the 2,000 meters installed, is 700,000 cubic feet (Volcanic Oil and Gas Company). The population is about 10,000 and gas is used freely. On this purely domestic basis of consumption, 30 per cent., or ten years, more should be added to the life of the field.

In 1894 a select committee of the Legislature was appointed to enquire into the production of natural gas in Ontario. After investigating the matter thoroughly this committee stated in its report:—

"That as regards the economic uses of natural gas, witnesses are agreed that it is one of the most valuable of all fuels, and in view of the limited supply it appears desirable that its use as far as possible should be confined to the purposes of domestic fuel and in the production of the finer classes of manufacture."—(Journal Legislative Assembly, Vol. XXVII., 1894, Appendix No. 1, p. 6.)

Nothing has happened since to modify the conclusion arrived at then; in fact, the continued depletion of all fuel supplies emphasizes the soundness of this judgment.

In calculating the life of the field, therefore, it seemed desirable to give it under the best possible conditions. The actual life will depend on how nearly these conditions are fulfilled.

Relative Value of Oil and Gas

As the units used in speaking of gas and oil are quite different, it seems desirable to reduce both to some common basis so that a comparison may be made between the two. Natural gas is employed mainly as a source of heat, the amount used directly for light being relatively insignificant. Oil, on the other hand, is chiefly known as an illuminant. Gas and oil will be compared both as heat producers and illuminants. The most rational method is to find the heating efficiency of each. When the two products are used for lighting under the most economical conditions, that is with a mantle, the light given is proportional to the heating power. What occurs is that the mantle is heated to a high temperature and radiates the light; where the naked flame is used the particles of carbon become heated and act as radiators.

Poole, "Calorific Power of Fuels," p. 251, gives the following data concerning various oils:—

Bothwell oil	173,400 British thermal units per gal.
Ohio, refined	164,736 " " " "
Ohio, crude	172,800 " " " "
Canadian Oil, refined (Dr. Ellis' report quoted above)	154,585 " " " "

Natural gas averages about 1,000 B.T.U. per cub. foot; thus Poole, p. 254, gives 1,050 as the mean for Ohio gas, which is most closely allied with the gas in Kent. No determinations of the Kent gas for heating efficiency have been made, as far as the writer is aware. With 1,000 cub. feet as the unit for gas, this would give of course 1,050,000 B.T.U., and assuming the average efficiency of the oils given it will be seen that about 6.5 gal. of oil are equivalent to 1,000 cub. ft. of natural gas. A barrel of oil (35 gal.) is therefore equal to about 5,400 cub. ft. of natural gas in heating power and consequently in illumination.

Coming to the question of the quantity of oil that will be produced, no such calculation of the amount in a given field can be made as was done with gas. The rock pressure as an indicator fails here. The oil being a fluid cannot be compressed like the gas. Moreover it is much more viscous than the gas, and consequently cannot find its way as readily through the rock. All we have to rely on is the actual results in production from wells drilled; where these are sufficient in number (several hundred in this case) and show the same general results, the evidence is strong enough to form a conclusion. As far as the strata already tested are concerned (*i.e.*, to about 1,430 feet in depth) the information seems sufficient. Thus the production from the oil territory in question in East Tilbury, Romney and Raleigh is given in the Eighteenth Report of the Bureau of Mines, p. 33, as follows:—

1906 (first production in this year)................	106,992 barrels.
1907	411,588 "
1908	201,283 "
1909 (See present volume)	124,003 "
Total	843,866 barrels.

It will be noticed that there has been a very rapid falling off in the oil production—about 50 per cent. in each year. For 1910 the amount will probably not exceed 50,000 to 60,000 barrels. The yield of well after well has declined in a way that must be painfully monotonous to the operators. The total production of oil, therefore, up to the end of 1909 is equivalent, on the basis explained above, to 4,556 million cubic feet

of gas. As the minimum gas supply in the Kent field was calculated to be 61,000 million feet, the oil production to the end of 1909 is equivalent to only about one-thirteenth the estimated gas production. The probable yield of 50,000 barrels of oil for 1910, or 1,750,000 gal., is equal to 270 million feet of gas, or less than the average production of gas for one week from that field during 1910. There may, of course, be oil in lower strata, but that is only a possibility.

Looking at the matter in another way, 6.5 gal. of oil are equal to 1,000 cub. feet of gas in efficiency, or 6,500 gal. of oil equal one million feet of gas. At the rate of 5 million feet per day, assumed above in calculating the life of the gas field, this is equivalent to 32,500 gal. of oil per day, or somewhat less than 1,000 barrels per day, more exactly 339,000 barrels per year, and as was shown above, this can continue for thirty-three years at least.

Comparing the cost to the consumer of illumination derived from oil and gas respectively, it will be seen that he would have to buy refined oil for the same price as is paid the producer for crude oil delivered at the railroad, in order to have an equal amount of light for the same cost as from gas bought at the current rates in that locality. Thus $1.24 per barrel or 3.5 cents per gal. is paid for crude oil; multiplying this by 6.5 the number of gal. equal to 1,000 ft. of gas, gives about 23 cents as against 25 cents per 1,000 feet ordinarily paid for natural gas from that field. Crude oil is of course not all burning oil. In this locality it consists of about 40 per cent. kerosene or illuminating oil, the balance being lighter products such as benzine, etc., and the lubricating oils.

The relation between illuminating power and oil consumption in everyday practice is very difficult to arrive at exactly by direct test. The art of using the oil to the very best advantage is not ordinarily as far advanced as it is in the case of gas. The illumination depends mainly on the quantity of oil burned in a given time. Other circumstances have influence, however, as Argand burners, for instance, give more light from an equal amount of oil than flat wick burners. "The character of the wick, the dimensions of the chimney and the size and shape of the oil reservoirs are factors of only slightly less importance than the form of the burner." (Boverton Redwood, Petroleum and Its Products, Vol. II., p. 674.) Redwood states that the average consumption of oil per candle light per hour, using duplex Argand burners, is 50 grains, equivalent to 1,120 candle-hours per gallon of oil. With ordinary burners the oil consumption would be much greater. Artificial gas burnt without a mantle gives about 2,800 candle-hours per 1,000 cub. ft. No one would nowadays think of burning natural gas without a mantle. With the use of this about 2½ cubic feet per hour of natural gas give 25-candle lights or 1 cub. ft. gives 10 candle-hours, and 1,000 cub. ft. give 10,000. Therefore 1,000 cubic feet of natural gas are equivalent to slightly less than 9 gallons of oil in illuminating power under ordinary circumstances. Of course as the conditions under which oil is burnt are perfected, the relations will approach those explained before, where 1,000 cubic feet of gas were found to be equal to 6.5 gal. of oil.

CONCENTRATION OF LOW GRADE MAGNETITES

By George C Mackenzie

During the winter of 1907-1908 the writer made some preliminary tests with low grade magnetites, in connection with a report on "The Iron and Steel Industry of Ontario," published in the Seventeenth Report, Ontario Bureau of Mines. A few notes were compiled on the general problem of magnetic separation as applied to iron ores, and descriptions were added of three large magnetic separating mills operating in the United States. It will be unnecessary, therefore, to make any detailed description as regards the modern process, beyond a few remarks on the construction and operation of the separating machines that were used in making the tests now under consideration.

Ontario Rich in Low Grade Magnetite

Ontario, as far as we know at present, is comparatively poor in deposits of merchantable iron ore, and conversely may be said to be rich in deposits of low grade material. This fact is well known to everyone familiar with the situation, and is in part responsible for the heavy consumption of imported United States ores, as compared with the meagre tonnage of native ores smelted each year in Ontario furnaces. The question naturally arises: Are our numerous deposits of low grade magnetites to be considered of no value in the crude state, at the present market price of the rich United States ores? The Ontario furnaceman will affirm that such is the case, because he must pay a maximum figure for his fuel, and naturally is desirous of smelting only those ores that yield an amount of merchantable pig iron sufficient to insure the operation of his furnace upon a profitable basis. If he could secure cheaper fuel, he could afford to smelt leaner ores, but so long as he must pay between five and six dollars a ton for his coke, furnace economy requires an ore mixture yielding a maximum percentage of iron.

The Problem of Economical Concentration

By far the larger number of our low grade deposits consists of impure magnetites, which naturally leads one to suggest the process of magnetic separation, and subsequent marketing of the concentrated product. At first glance the solution of this problem appears to be easy. The crude ore is crushed to free particles of gangue rock from particles of magnetite, and is then passed through magnetic separators, saving the valuable iron and allowing the gangue to go to waste. Unfortunately the desired result is not so easily accomplished from the standpoint of commercial utility. When it is considered that the concentrated ore must compete with natural ores that are marketed at three to five dollars a ton, it is evident that the low grade material must be mined very cheaply, and then crushed and concentrated without excessive cost. Cheap mining is not possible unless operations are conducted on a sufficiently large scale, which, in turn, means that the deposits must be of such magnitude that readily admit of economical working. Then again, the concentrated product may be in a state of fine subdivision (depending upon the extent of crushing necessary to produce the desired concentrate) and therefore unfit for direct use in the blast furnace, necessitating either briquetting or nodulizing—an additional item of cost. Hence the problem is complex, and requires careful consideration of all factors likely to influence the financial success of the undertaking.

On the other hand, there are several important features connected with properly prepared concentrated ores, which give them distinct value over and above that of natural ores. The first and most important is the high iron content; secondly, the absolute standardization of the concentrated ore, which means that the iron and gangue contents will vary but slightly from day to day, affording the furnaceman an oppor-

tunity of carrying the maximum burden allowed by the fuel, with the elimination of any variable condition that is necessarily present when using natural ores. And thirdly, a greatly reduced loss due to flue dust, a very troublesome matter in every furnace using natural ores.

All of the foregoing items have, both singly and collectively, a direct influence on the fuel consumption per ton of iron made, and as Ontario furnacemen must use costly fuel, it would appear that a careful study of the situation is desirable before condemnation is made of the more costly concentrated ores.

The most accurate method of determining the value of any iron ore is naturally on actual trial by smelting the ore, under normal conditions, in a blast furnace. This is, of course, out of the question in the present instance, for obvious reasons, and therefore the only alternative for making comparison is on arithmetical calculation, based on well known factors, determined within reasonable accuracy by modern furnace practice.

Relative Value of Ores at the Furnace

It is presumed that the furnaceman has the opportunity of purchasing one of two different ores. He will naturally be desirous of buying the ore which will yield him the largest return for his money, and in all probability will, before he decides upon purchase, calculate the value of each ore to him, laid down at his furnace, under the conditions in which he is forced to operate. One ore may cost more per ton f.o.b. furnace than the other, but the higher-priced ore may contain more iron and less slag-forming materials, and therefore be more economical of fuel, yielding pig iron at a relatively lower cost per ton. The two ores in question may be assumed as follows:—

(A.) A typical Lake Superior, United States, ore, with the following analysis:—

Iron.	Silica.	Alumina.	Lime.	Magnesia.	Phosphorus.	Sulphur.
p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.
54.00	9.32	1.37	0.17	0.22	0.041	0.006

(B.) Briquettes made from Temagami concentrates, analysing as follows:—

Iron.	Silica.	Alumina.	Lime.	Magnesia.	Phosphorus.	Sulphur.
p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.
63.60	8.5	Trace	0.00	0.00	0.007	Trace

It is desired to ascertain the relative value of the above two ores to the furnace under the following assumed conditions[1]:—

Coke costs $5.25 per net ton delivered.

Limestone costs $0.75 per gross ton delivered.

Fixed charges are $2.25 per gross ton of pig iron.

Cost of producing one ton gross of pig iron not to exceed $16.00.

Bessemer iron to be made, containing approximately 1 per cent. of silicon and 95 per cent. of iron.

Temperature of hot blast to be 1000-1200 degrees F.

It is also assumed that for the reduction, impregnation and melting of the pig iron 66 per cent. of carbon will be required, and for the formation and melting of the slag about 25 per cent. of carbon will be required.

The slag is assumed to conform approximately in composition to the ratio

$$\frac{\text{RO Bases}}{\text{Silica} + \text{Alumina}} = \frac{52}{48} = 1.083 \text{ (Slag Ratio)}$$

The analysis of the coke is as follows:—

Fix. Carbon.	Silica.	Alumina.	Lime.	Magnesia.	Phos.	Sulphur.	Ash.
p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c	p.c.
85.00	6.16	2.57	0.40	0.26	0.13	1.26	10.5

[1] For this and similar calculations see "The Blast Furnace and the Manufacture of Pig Iron," by Robert Forsyth, pages 47 and 168.

The analysis of the limestone is as follows:

Silica.	Alumina.	Lime.	Magnesia.
p.c.	p.c.	p.c.	p.c.
3.96	0.32	39.25	10.85

The available base in this limestone is calculated as follows:

Acids.		Bases.	
Silica	3.96	Lime	39.25
Alumina	0.32	Magnesia	10.85
	4.28		50.10

4.28 × 1.083 (Slag ratio) = 4.64 bases needed to flux acids,
Hence 50.10—4.64 = 45.46 available base
And $\frac{100}{45.46}$ = 2.2 Efficiency of stone.

The slag-forming constituents of the stone are silica + alumina + lime + magnesia = 54.38 per cent. of the stone.

The available carbon in the coke is calculated as follows:

Acids.		Bases.	
Silica	6.16	Lime	0.40
Alumina	2.57	Magnesia	0.26
	8.73		0.66

8.73 × 1.083 (Slag ratio) = 9.45 bases needed to flux acids,
Subtract........ 0.66 bases present

Leaves .... 8.79 bases to be added.

Then 8.79 × 2.2 (efficiency of stone) = 19.34 pounds of stone required to flux ash in 100 lb of fuel.

And 1.26 [illegible] 2.2 = 4.85 pounds of stone required to flux sulphur in 100 lb. of fuel.

Total stone required....... 24.19 pounds per 100 lb. of fuel.

The slag formed by the fuel ash and sulphur equals the ash and sulphur plus the flux needed, thus:

8.73 + 0.66 + 1.26 + (24.19 × .5438) = 23.80 pounds weight of slag formed per 100 pounds of fuel;

And as the slag requires 25 per cent. of carbon for its formation and melting.

23.80 × 0.25 = 5.95 pounds of carbon are required to melt slag from 100 pounds of of fuel.

Fixed carbon in coke	85.00
Carbon needed for slag	5.95
	79.05 available carbon in coke.

We are now prepared to calculate the relative value of the two ores under consideration.

The Lake Superior Ore

Consider first the Lake Superior ore. The amount of flux needed and slag formed is found as follows:

Acids.		Bases.	
Silica	9.32	Lime	0.17
Alumina	1.37	Magnesia	0.22
	10.69		0.39
Less reduced to silicon in the pig iron	1.21		
	9.48 acids to be fluxed.		

9.48 × 1.083 = 10.26 bases needed.
Less . 0.39 bases present.

9.87 bases to be added.

9.87 × 2.2 = 21.714 pounds of stone required per 100 pounds of ore. And as $\frac{95.00}{54.00}$ = 1.759 tons of ore are required to make one ton of pig, therefore 1.759 × 0.21714 = 0.38194 tons of stone required per ton pig. The slag formed by the ore per ton pig equals the slag-forming constituents of the ore, added to those of the stone needed to flux the ore; thus

$$\frac{9.48 - 0.39}{100} \times 1.759 = 0.17361 \text{ tons of slag from ore.}$$

$$\frac{54.38}{100} \times 0.38194 = 0.20769 \text{ tons of slag from stone.}$$

0.38130 total tons of slag from ore and stone.

Fuel consumption per ton of pig iron:

For the formation and melting of slag 0.38130 × 0.25 = 0.09532 parts of carbon are required.

For reduction, impregnation and melting of pig iron per gross ton containing 1 per cent. of silicon = 0.66000 parts of carbon are required.

Total carbon required for pig and slag	0.75532

Available carbon in coke = 79.05 per cent.

Therefore $\frac{0.7553}{0.7905}$ = 0.9554 gross tons of coke are required per ton of pig = 2,140 pounds of coke.

Allowing 5 per cent. for braize, 2,140 lb. of coke in the furnace represents 2,252 pounds purchased at $5.25 per net ton.

Total limestone required per ton of pig:

For the ore	0.38195	gross tons
For the coke 0.955 × .2419	0.23101	" "
Total stone per ton pig	0.61296	" "

Costs:

The fuel per ton pig will cost 1.126 net tons @ 5.25..................	$5.91
Limestone, 0.613 gross tons @ $0.75 per ton	0.46
Fixed charges	2.25
Total cost pig iron, exclusive of ore	$8.62

Maximum cost of iron allowable	$16.00
Cost of iron, exclusive of ore	8.62
Value of 1.759 gross tons of ore	$7.38

or $4.19 = value per gross ton of the Lake Superior ore delivered.

Temagami Briquettes

Now consider the case of the Temagami briquettes.

The amount of flux needed and slag formed is calculated as follows:

Acids.		Bases.	
Silica	8.50	Lime	—
Alumina	—	Magnesia	—
	8.50		—

Less 1.42 reduced to silicon in the pig iron.

7.08 acids to be fluxed.

$7.08 \times 1.083 = 7.667$ bases needed.

$7.667 \times 2.2 = 16,867$ pounds of stone required per 100 pounds of briquettes.

And as [illegible] $= 1.493$ tons of briquettes are required to make 1 ton of pig iron, then $1.493 \times 0.16867 = 0.25182$ tons of stone required per ton of pig iron

The weight of slag formed will be:

$\frac{7.08}{100} \times 1.493 = 0.105704$ tons of slag from the briquettes,

$\frac{54.36}{100} \times 0.25182 = 0.13693$ tons of slag from stone.

Total $= 0.242634$ tons of slag from briquettes and stone.

Fuel consumption per ton of pig iron:

For the formation and melting of slag 0.24263×0.25 parts of carbon are required.	0.06065
For reduction, impregnation and melting of pig iron per gross ton containing 1 per cent. of silicon parts of carbon are required	0.66000
Total carbon required for pig iron and slag.	0.72065

Available carbon in the coke = 79.05 per cent.

Therefore $\frac{0.72065}{0.7905} = 0.911$ gross tons of coke required per ton of pig iron = 2,040 pounds of coke, and allowing 5 per cent. for braize, 2,040 pounds of coke in furnace represent 2,147 pounds purchased at $5.25 per net ton.

Total limestone required per ton of pig iron:

For the briquettes	0.25182 gross tons.
For the fuel 0.911×0.2419	0.22037 " "
Total stone per ton pig iron	0.47219 " "

Costs:

The fuel per ton pig will cost, 1.073 net tons @ $5.25	$5.63
Limestone per ton pig, 0.472 gross tons @ $0.75	.36
Fixed charges per ton pig iron	2.25
Total cost of pig iron, exclusive of briquettes	$8.24

Maximum cost of iron allowable	$16.00
Cost of iron, exclusive of briquettes	8.24
Value of 1.493 gross tons of briquettes	$7.76

or $5.20 = value per gross tone of Temagami briquettes delivered.

The Ore Samples

The experimental tests made in 1907-8 were carried out with small samples of ore not exceeding 25 pounds in weight, so that the results obtained, although encouraging, were certainly not conclusive as regards the merits of the process for the successful

concentration of Ontario ores. It was decided, therefore, to carry out the present experiments at the Kingston School of Mines, upon a larger scale, with samples of at least three tons, thereby obtaining more accurate representation of the crude ores, and at the same time securing material enough to put the tests through in greater detail.

In the selection of samples an attempt was made to procure ores that varied, not only in chemical analysis, but also in physical structure, the varieties thus obtained illustrating the characteristics of the more prominent low-grade magnetites, and affording demonstration of the fact that the concentration of each ore is a particular problem in itself.

Following is a list of ores that were received and tested, the localities from which they came, and the names of the people responsible for their shipment:

Ore.	Locality.	Name of Sender.
Temagami	Temagami Station	Thos. B. Caldwell, Lanark.
Moose Mountain	Township of Hutton	Moose Mountain, Ltd., Sudbury.
Coe Hill	County of Hastings	George Collins, Trenton.
Calabogie	County of Renfrew	Thos. B. Caldwell, Lanark.
Radnor	County of Renfrew	Canada Iron Corporation, Montreal.

The sample of Temagami jaspilyte fairly represents ores of similar character that are found in many localities throughout the northern townships. So far as is known, no considerable body of hematite has been discovered in association with the jaspilyte formations of Ontario, although similar formations on the Vermilion range in Minnesota are at times accompanied by large bodies of rich hematite. If nature has been neglectful in this respect with our formations, she has certainly not been niggardly with her supply of crude jaspilyte, and therefore it is a matter of some importance to determine whether or not these lean ores can be considered an asset from the standpoint of concentration. The sample sent in by Mr. Caldwell was taken from several test pits on the property, and may be considered a fair average of the range. Analyses show the iron content to be about 37 per cent., with sulphur and phosphorus both low. Physically the ore (if such it may be called) consists of very fine-grained magnetite, alternating in narrow bands of one-eighth of an inch to two inches in thickness, with bands of quartz of about equal thickness, which are white or grey chert, or red or black jasper.

The sample of silicious ore from Moose Mountain, in the township of Hutton, is similar in analysis to the Temagami jaspilyte, but instead of presenting the banded structure of the latter, the iron and silica are evenly distributed throughout, and the crystallization is so fine that excessive pulverization is required to liberate the minute particles of magnetite. The main point in concentrating Temagami and Moose Mountain ores is the elimination of silica: at the same time keeping both sulphur and phosphorus below the Bessemer limit.

The sample of Coe Hill ore was obtained through Mr. George Collins, manager of the Central Ontario railway. This ore may be classed as a high sulphur magnetite, as it contains nearly two per cent. of that impurity. The sulphur exists in the form of magnetic pyrites, pyrrhotite, and, as such, is difficult to remove by magnetic separation. Phosphorus is low, the crude containing in the neighborhood of not more than 0.03 per cent. The iron content of the sample submitted was a little over 52 per cent., so that the ratio of crude units per unit of concentrate will not be high. The ore is crystalline, slightly granular, and if the sulphur were in the form of ordinary iron pyrites instead of the magnetic variety, the problem of concentrating would be simplified.

Sample No. 4, from the Tommy R. pit at Calabogie, was sent in by Mr. Thos. B. Caldwell. This ore is a fair type of many similar low-grade magnetites found along the Kingston and Pembroke railway. Its iron content is nearly 42 per cent., with sulphur and phosphorus both present in objectionable, although not excessive, amounts.

0.139 per cent. of the former and 0.17 per cent. of the latter. Very little iron pyrites can be seen in hand specimens, and it is probable that if most of the sulphur exists in the form of FeS_2, it is in very minute particles. The physical structure of the ore is crystalline, and presents a distinct schistose appearance, in which particular it differs from the majority of eastern Ontario ores.

The sample of Radnor ore was sent in by The Canada Iron Corporation, from their mine of that name in Grattan township, county of Renfrew. Radnor is a coarse, crystalline ore, distinctly granular, and in this respect is an exception to the general run of eastern Ontario ores. Analysis shows that it is somewhat similar in composition to Calabogie, being low in iron, and containing sulphur and phosphorus in appreciable quantities. From the physical structure of Radnor crude it would appear that relatively coarse crushing, with subsequent magnetic concentration, would yield a concentrate of high order, and the tests with this ore proved that assumption to be correct.

Both Calabogie and Radnor ores are examples of crude material that require not only the elimination of silica, but also the removal of sulphur and phosphorus. With Radnor ore this was accomplished easily, without excessive grinding, and although Calabogie yielded a first-class concentrate, it was more difficult to obtain. The concentration of Coe Hill crude is a problem in itself. Not only is the sulphur content prohibitory, but the percentage of insoluble matter is also a serious detriment. Without the insoluble, the ore would probably answer to the Gröndal method of treating pyrites residues. However, as both sulphur and insoluble matter are present in excessive amounts, the only alternative is magnetic separation to eliminate silicious gangue, and, if possible, some sulphur; then, as the concentrates would still contain too much sulphur, a subsequent calcining and agglomerating of the fine material would be necessary.

Outline of the Testing Work Attempted

Before giving detailed descriptions of the tests carried out with the different samples, it will be advisable to explain the general methods followed throughout the work, and indicate the points upon which the investigation rested.

In the first place, the most important point is the attainment of a high iron content in the heads product, consistent with the percentage of magnetite saved in the concentrate, and the percentage lost in the tailings. In direct relation to the foregoing is the number of crude units required to make one unit of concentrate, *i.e.*, the ratio of concentration.

Secondly, the elimination of sulphur, phosphorus and silicious gangue material to uniformly low percentages that would admit of listing the concentrates as first-class Bessemer ores.

Thirdly, the extent to which crushing and pulverizing had to be carried, to free constituent minerals in the crude, so that the first two requirements could be attained.

Fourthly, the effect of crushing the crude to a certain point, and then sizing the crushed ore by passing it over screens of different mesh, thereby assembling particles of about the same size, irrespective of specific gravity, the practical effect of which is a greatly increased efficiency in the subsequent magnetic separation. Incidentally, this preliminary crushing and sizing would indicate the relative hardness of the magnetite and gangue rock by the percentage of iron contained in different sizes, and at the same time illustrate the general crushing quality of the several ores.

Fifthly, ascertaining by sieve test the relative proportion of fines that are produced in concentrates by the dry process, as an indication of the possibility of smelting such concentrates without the need of briquetting or nodulizing.

Sixthly, the possibility of briquetting and desulphurizing concentrates produced by the wet process.

Machines Used in Making the Tests

1 Blake crusher, 10 x 7 inches;
1 Set Cornish rolls, 16 inches diameter;
1 Krupp dry ball mill, equipped with Nos 10, 20, 40 and 60 mesh screens;

1 Colorado Iron Works impact screen, equipped with Nos. 4 x 3, 8 x 4, 10 x 6, 12 x 8, 16 x 12, 20 x 16, 24 x 20, 30 x 24 and 40 x 30 mesh screens;
1 Abbe Engineering Co. pebble mill (small size);
1 Complete set of laboratory testing screens;
1 Drum magnetic separator, built in the School of Mines workshops during the winter of 1907-1908. The exciting field of this machine consists of 12 stationary electro magnets, carried on a cast iron spider, and enclosed in a brass drum 14 inches across the face and 18 inches in diameter, the drum being protected by a thin rubber sleeve. The electro magnets have a capacity of 10 amperes at 110 volts, and are arranged in a series of alternate polarity, the position of the field being altered at will by means of an outside arm attached to the spindle carrying the magnets. The drum is made water-tight, and may be used in either of two box wells, placed side by side for dry or wet concentration, an overhead travelling trolley being provided to lift the drum from one box to the other. Power for rotating the drum is supplied by a ¾-h.p. electric motor.
1 Belt Magnetic Separator, of the Ball and Norton belt type.

This machine was built during the winter of 1908-1909, in the School of Mines workshop, under the supervision of L. W. Gill, Professor of Electrical Engineering. The exciting field consists of three powerful horse-shoe electro magnets, suspended between the pulleys carrying the 12-inch take-off belt. The magnets have a total capacity of 15 amperes at 110 volts. Terminal wires are so arranged that the polarity of each and every magnet can be reversed at any time, and the strength of each magnet, being controlled by a separate rheostat, facilitates the operation of the machine in making a three part separation, *i.e.*, heads, middlings and tailings. The crude ore may be fed by the ordinary belt feed, as in the Ball and Norton type, or by means of a slotted shaking table operating beneath the take-off belt. Power for driving the take-off belt, and feeding arrangement, is supplied by a ¾-h.p. electric motor.
1 Feed bin, holding about 1,200 lbs. of ore, feed being controlled by an ordinary 12-inch roller, driven at uniform speed by a ⅛-h.p. electric motor.

Preparing the Ore for Separation

Preliminary Crushing:—The shipments of ore, as received, were broken by the Blake crusher to about 1-inch size, and then sent to the Cornish rolls, where the material was reduced to ¼- or ⅛-inch, the discharge from the rolls passing over a 4 x 3 or 6 x 4 impact screen, oversize being returned to the rolls until all material was reduced to the required size.

Sampling and Weighing:—The crushed ore was then piled on a sheet-iron floor, and sampled by the ordinary process of coning and quartering, the whole amount being so treated, and reduced by successive quarterings until a sample of about 10 lb. was obtained. This sample was bagged and marked with the name of the ore and the letter A, indicating that it was the general sample of that particular shipment. The main bulk of crude was then sacked and weighed.

Drying:—No attempt was made to dry the crude ore. All shipments were received in bags or barrels, thus affording protection against excessive moisture, and it was found that the subsequent crushing and sizing resulted in removing any contained moisture to a fraction of one per cent. This does not mean that drying could be dispensed with in commercial dry separation of these ores. The conditions under which the tests were carried out were favorable for the elimination of moisture, but it is not at all likely that such conditions would exist in actual practice.

Classifying for Dry and Grinding for Wet Separation

After weighing, the crude was divided into two portions, approximately two-thirds being taken for dry separation, and one-third for wet separation. The portion of crude for dry separation was then sent to the impact screens. The first screen used, being,

of course, the finest, removed the dust particles, the oversize being returned to a screen of larger mesh, removing the next size of particles, oversize being fed to a screen of still larger mesh, and so on until the whole of the crude had been classified according to size of particles. Each grade or size was then sampled by the same method described above for the original crude, the samples marked with the name of the ore, and a designating number corresponding to the size of the material. The different sizes were then sacked and weighed, and the percentages of each size calculated with relation to the original weight of crude.

Screen Schedule

The following schedule shows the size of different screens used throughout the testing work. For comparison with the standard sizes adopted by The Institution of Mining and Metallurgy:—

Screens used.	Mesh per linear inch.	Decimal size of wire, inch.	Size of opening, inch.	Screens used.	Mesh per linear inch.	Decimal size of wire, inch.	Size of opening, inch.
Impact Screens, Colorado Iron Works.	4 x 3	0.047	0.203	Ball Mill Screens, W. S. Tyler Co.	10	0.047	0.053
	6 x 4	0.035	0.132		20	0.025	0.025
	8 x 4	0.035	0.090		40	0.0135	0.0115
	10 x 6	0.028	0.072		60	0.0080	0.0091
	12 x 8	0.023	0.06	Testing Screens, W. S. Tyler Company.	10	0.018	....
	16 x 12	0.018	0.0445		20	0.0165	0.0335
	20 x 16	0.017	0.033		40	0.01025	0.0147
	24 x 20	0.014	0.027		60	0.0075	0.0091
	30 x 24	0.014	0.0195		80	0.00575	0.00675
	40 x 30	0.009	0.0160		100	0.0045	0.0055

The portion of crude for wet concentration was then split into two or three equal lots, each lot being ground separately in the Krupp ball mill, using a 10-mesh screen for one lot, a 20-mesh screen for the second, and a 40-mesh screen for the third. It was not considered necessary to sample the ball mill product, as each lot was a portion of the original crude, and therefore represented by the original sample A.

Concentrating

Dry Separation:—In making these tests the belt machine was used exclusively, its capacity being greater, and adjustments easier of regulation and control than the drum machine. Each size or grade of ore was put through separately, the machine being adjusted for the production of tails that were discharged as waste, heads that were accepted as final, and middlings that required re-grinding and re-separation. The middlings were then re-treated until the iron content fell below 15 per cent. in the case of Temagami, and below 12 per cent. in all other cases. The final concentrates and final tailings were caught in respective bins, and were weighed and sampled, the samples being selected by the same process described for the crude ore. Two samples of each concentrate were taken, one for chemical analysis, and one for sieve test to determine the relative percentage of fine and coarse particles.

Wet Separation:—Wet separation was carried out with the drum machine arranged to work on the Gröndal system. It was found that the exciting field of this machine was too weak to effect a clean separation of magnetite from gangue at one pass. Accordingly the height of the drum above the water and the field strength were adjusted to make clean heads, and the tailings were re-passed until the maximum of

free magnetite had been saved. This was usually accomplished in two, and less frequently in three, re-passings of the tails. The final concentrates and final tails being collected in respective settling tanks, the water was then drained off, and the products dried, weighed and sampled. This method of concentrating is exactly the reverse of that followed in the Gröndal process. In the Swedish system, the separating machines are powerful enough to make clean tailings at once, and the head products from the first operation, sometimes containing free gangue mechanically entangled, are re-passed to eliminate this gangue in a secondary machine. If the concentrate from the secondary machine is still too low in iron, re-grinding may be resorted to, followed by a final concentration. Only two of the ores tested, namely, Temagami and Moose Mountain, required intermediate grinding, and re-concentration of the heads; with the rest no difficulty was experienced in obtaining concentrates well over 60 per cent. in iron and low in phosphorus and sulphur (with the exception of Coe Hill) without excessive grinding.

Analyses

All the analyses were made by Mr. N. L. Turner, chemist in charge of the Provincial Assay Office, Belleville.

Samples of crude marked A were analyzed for soluble iron, insoluble residues, sulphur and phosphorus. The percentage of magnetite was calculated from the soluble iron after deducting the percentage of iron present in iron pyrites or pyrrhotite. Qualitative tests were made for titanium, but this element was found to be absent in all the samples. Samples of the classified crude marked 1, 2, 3, etc., were analyzed for soluble iron, insoluble residues and sulphur, magnetite percentages being calculated from the soluble iron, with correction for iron sulphides. Samples of concentrates were analysed for soluble iron, insoluble residues, sulphur and phosphorus, magnetite percentages calculated as previously described. Samples of tailings were run for soluble iron; and sulphur magnetite calculated from soluble iron with sulphide correction. Samples of briquetted concentrates were analyzed for total iron, silica, sulphur and phosphorus.

Tabulating the Results of Concentration

With the description of the test on each ore will be found a "mill log sheet," upon which are entered all the data pertaining to that particular test. This method of presenting the results will, it is hoped, be of assistance to the reader who has not the time or the inclination to read through the full printed matter. An effort was made to make the log sheet as simple and untechnical as possible, and at the same time to illustrate the relative efficiency of wet and dry separation for each ore.

At the head of the log sheet will be found the number of the test and the name of the ore treated, the extent to which crushing was carried, and the general analysis of the original crude. The left hand side of the sheet is devoted to dry separation; the weight of ore for dry test is given, and the method of classifying by the impact screens is illustrated. The table under the heading "Dry Concentration" contains all data of crude ore, concentrates, tailings, dust loss, and efficiency of separation. Under "Crude Ore" will be found the numbers of the classified samples, their grade according to mesh size, the weight of each grade, and the percentage of each grade with respect to the original weight of crude. The analysis of each grade is given and the total averages at the foot that should check, within reasonable accuracy, with the results of analysis of sample A. Under "Concentrates" will be found the weight and percentage of concentrate obtained from each grade, together with the analysis, the totals and averages being entered at the foot of the table. Under "Tailings" are entered the weight and percentages, with analysis. Sulphur determinations are given only in those cases where the original ore was high in that element. The figures under "Dust Loss" represent the weight and percentage of material lost during the test, and were obtained by subtracting the weight of concentrates plus tailings from the

original weight of crude. Under "Efficiency" will be found the percentage of magnetite saved in concentrate and lost in tailings. Percentages of magnetite lost were obtained by subtracting the percentage saved from 100, and represent the total loss. Percentages of magnetite saved, and units of crude required per unit of concentrate were calculated from the analyses according to equations given in the last report.[2] As a check upon the calculations just described, a recapitulation of the results of dry concentration is added. The weights of magnetite in the crude, concentrate, and tailings are calculated from the actual weights, the weight and per cent. of magnetite in the dust obtained by subtraction. The percentages of saving and loss thus obtained show very close approximation to the figures obtained by the equations mentioned above.

On the right-hand side of the log sheet the data pertaining to wet concentration is given. The weight of crude and the extent of grinding for each portion of crude in the ball mill is indicated. Under "Crude Ore" are entered the weights, the mesh size, and the analyses. Under "Concentrates" are given the weights, percentages and analyses of the head products, and under "Tailings" the weights, percentages, and analyses of the tails. Figures representing slime loss were arrived at by the difference in weight between the original crude and the concentrates plus tailings. Efficiency results were calculated by the same method described for dry concentration. A recapitulation for the sample that yielded the best concentrate is added, the calculations being the same as described for dry separation, and the slime loss figures obtained by subtraction.

Metallic Equivalent to Magnetite

The following table will be found convenient in ascertaining the percentage of magnetite corresponding to any percentage of iron. In using the table, correction should be made for the amount of iron present in any form other than Fe_3O_4:—

Per Cent. Iron. Fe	Per Cent. Magnetite. Fe_3O_4	Per Cent. Iron. Fe	Per Cent. Magnetite. Fe_3O_4
.01	.013808	29.0	40.04408
.02	.027616	30.0	41.42491
.03	.041424	31.0	42.80574
.04	.055233	32.0	44.18657
.05	.069041	33.0	45.56740
.06	.082849	34.0	46.94823
.07	.096658	35.0	48.32906
.08	.110466	36.0	49.70989
.09	.124274	37.0	51.09072
.10	.138083	38.0	52.47155
.20	.276166	39.0	53.85238
.30	414249	40.0	55.23321
.40	.552332	41.0	56.61404
.50	.690415	42.0	57.99487
.60	.828498	43.0	59 37570
.70	.966581	44.0	60.75653
.80	1.104664	45.0	62.13736
.90	1.242747	46.0	63.51819
1.0	1.380830	47.0	64.89902
2.0	2.76166	48.0	66.27985
3.0	4.14249	49.0	67.66068
4.0	5.52332	50.0	69.04151
5.0	6.90415	51.0	70.42234
6.0	8.28498	52.0	71.80317
7.0	9.66581	53.0	73.18400
8.0	11.04664	54.0	74.56483
9.0	12.42747	55.0	75.94566
10.0	13.80830	56.0	77.32649

[2] 17th Rep. Bur. Min., 1908, p 229

Metallic Equivalent to Magnetite.—Continued.

Per Cent. Iron. Fe	Per Cent. Magnetite. Fe_3O_4	Per Cent. Iron. Fe	Per Cent. Magnetite. Fe_3O_4
11.0	15.18914	57.0	78.70732
12.0	16.56997	58.0	80.08815
13.0	17.95080	59.0	81.46898
14.0	19 33163	60.0	82.84981
15.0	20.71246	61.0	84.23064
16.0	22.09329	62.0	85.61147
17.0	23.47412	63.0	86.99230
18.0	24.85495	64.0	88.37313
19.0	26 23578	65.0	89.75396
20.0	27.61661	66.0	91.13479
21.0	28.99744	67.0	92.51562
22.0	30.37827	68.0	93.89645
23.0	31.75910	69.0	95.27728
24.0	33.13993	70.0	96.65811
25.0	34.52076	71.0	98.03894
26.0	35.90159	72.0	99.41977
27.0	37.28242	72.42 (Theoretical)	99.999718
28.0	38.66325		

Test No. 1.—Temagami Jaspilyte

The most prominent physical characteristic of this ore is its banded structure. Hand specimens show clearly the alternate bands of magnetite and jaspery material varying from one-eighth of an inch to two inches in thickness. Some of these bands of magnetite are sharply defined and consist of almost pure Fe_3O_4, others are of a splintery nature intermixed with fragmental jasper, but the majority consist of minute crystals of magnetite associated with 20 to 30 per cent. of silicious gangue particles.

In the preliminary crushing of the ore it was found that the banded structure was of material assistance, affording lines of weakness that facilitated the reduction to a point where the major portion of magnetite bands were freed from adhering jasper. After this point had been reached, it became more difficult to pulverize the material to a degree where complete disintegration of the constituent minerals was effected. This is fully illustrated in the accompanying log sheet, which shows that the dry concentrate from 6-mesh material contained but 50 per cent. of iron, while concentrates obtained by the wet process after excessive pulverizing contained over 64 per cent. of iron. The extent of crushing obtained by breaking the ore to 1-6 inch is illustrated by the percentage figures under "Crude Ore" in the table of dry concentration, over 55 per cent. remaining larger than 10-mesh, with only 18.89 per cent. passing a 40-mesh screen; the iron content of the 40-mesh material falling to 31.24 per cent., affording evidence of the fact that the magnetite bands offer a greater resistance to crushing than the bands of non-magnetic material.

The results of dry separation are not satisfactory. Too much silica remains in the concentrate, and the percentage of phosphorus instead of being reduced is increased. The dry concentrates would make a very fair non-Bessemer silicious ore, the sieve test showing that the proportion of fines to coarse is not excessive. But it is doubtful whether the price obtained for such concentrates would admit of any profit. The percentage of magnetite saved is low. This could be bettered by finer crushing, but the saving effected would be at the expense of the granular character of the concentrates.

Concentration by the wet process affords much better results in the production of factory. The separation of 20-mesh material yielded heads that were on about a par a richer head product, but the saving of magnetite made cannot be regarded as satis-

factory. The separation of 20-mesh material yielded heads that were on about a par with the results of dry concentration. The next size, 40-mesh, yielded heads but one per cent. higher than those obtained from the 20-mesh. It was therefore necessary to pulverize finer than 40-mesh to obtain first-class concentrates. Following the methods adopted in the Gröndal process, the heads from the 40-mesh material were reground in the pebble mill to 60-mesh, and re-concentrated; this resulted in raising the iron content to nearly 60 per cent., reducing silica to about 15 per cent. and phosphorus to 0.015 per cent. These concentrates were again returned to the pebble mill and ground to 100-mesh, and the finely divided pulp on re-concentration yielded heads that contained approximately 65 per cent. of iron, and were accepted as satisfactory.

In the recapitulation of the results of this test, 2-2 cc., it will be noted that only 84.519 per cent. of the magnetite was saved. The finely divided pulp contained much magnetite in slimey condition, and it was found very difficult to save this, with the machine at hand. If magnetic slimers[3] had been available, there is no doubt that the slime loss would have been reduced materially, and the proportion of magnetite saved proportionately increased. Conclusions may be summed up as follows: The ore will crush fairly easily to a point where the banded structure is destroyed, beyond this, effective disintegration will be expensive unless cheap power is available. Dry concenration will not yield a Bessemer concentrate and will not save more than 85 per cent. of the original magnetite unless finer crushing is resorted to. A first-class Bessemer concentrate can be obtained by the wet process, after re-crushing the middling product to about 100-mesh. The percentage of magnetite saved will be low, and slime loss heavy unless magnetic slimers are employed.

In actual practice the scheme of treatment might be as follows: Dry crushing to about ¼-inch, followed by wet pulverizing in a ball mill to, say, 40-mesh; the ground pulp flowing to magnetic slimers, which would remove a large portion of non-magnetic slimes. From the slimers the pulp would go to the preliminary separators, concentrates from these first machines being re-ground in tube mills to 100-mesh or thereabouts, and re-concentrated in a secondary line of separators yielding the final heads product. It is almost unnecessary to add that the concentrates obtained by this process would require briquetting or nodulizing.

Test No. 2.—Moose Mountain

Moose Mountain silicious crude, although very similar to the Temagami jaspilyte in chemical analysis, differs radically in physical characteristics. The banded structure in the sample tested is totally absent, and in its place we have a close-grained, tough, compact rock consisting mineralogically of crypto-crystalline magnetite, silica, and amphibolitic material, the magnetite being evenly distributed throughout the mass. Tests made last year with this ore proved that dry separation yielded indifferent results and therefore, it was decided to make no detailed experiments in dry concentration. Much of the low grade Moose Mountain ore has, however, a banded structure, although, as already noted, such a banded structure does not occur in the sample tested.

The whole sample was crushed to 1-6-inch by the Blake crusher and Cornish rolls, and then divided into three portions that were pulverized to three different sizes in the ball mill. The ore was very difficult to crush, its tough, compact structure offering a maximum of resistance, and in putting through the three thousand and odd pounds of crude, the crusher and rolls suffered more abrasion than they did from all the rest of the ores together.

To illustrate the effect of dry concentration, 300 pounds of the 60-mesh crude was put through the dry separator, and although the heads were re-passed four times, the highest iron content obtainable was 51.40 per cent. Tailings were low enough in iron, and the percentage of recovery satisfactory, but it is apparent that as fine grinding is necessary, it will be more advantageous to concentrate wet, thereby making a heads product of greater value.

[3] 17th Rep. Bur. Min., 1908, p. 237.

The wet concentration of the 20-mesh size resulted in obtaining a concentrate too low in iron to be merchantable. Separation of the 40-mesh size yielded a concentrate that contained only 49.14 per cent. of iron, which was also considered too low, although it will be noted that the phosphorus content had dropped to 0.021. The separation of the 60-mesh material resulted in a concentrate containing 53 per cent. of iron, with sulphur 0.02 and phosphorus 0.015 per cent. This concentrate was then re-ground in the pebble mill, and the pulp after re-concentration yielded a 64.62 iron concentrate with sulphur 0.02 and phosphorus 0.008 per cent., a result that was accepted as satisfactory.

Recapitulation of the test on sample 3-3c. showed that over 91 per cent. of the original magnetite was saved, the balance being lost in the tailings and slimes, the slime loss in the case of this ore being considerably less than in the case of the Temagami jaspilyte.

The wet process is evidently the method that should be followed in concentrating this and similar ores, the scheme of treatment being approximately similar to that outlined for the Temagami ore, although the extent to which preliminary crushing should be carried will be greater and the costs relatively higher.

Test No. 3.—Coe Hill

Coe Hill ore is crystalline, slightly granular magnetite, containing a considerable amount of pyrrhotite (magnetic pyrites), sulphur being present to the extent of nearly 2 per cent. The non-magnetic gangue consists of silica, dark colored mica, hornblende, and a small proportion of calcite. Phosphorus is low, the average being about 0.03 per cent.

The ore breaks easily. The effect of crushing to 1-4 inch resulted in 30 per cent. of the material being fine enough to pass a 40-mesh screen, with a little over 51 per cent. larger than 10-mesh. If preliminary crushing had been carried to, say, 1-6 inch, the percentage of dust particles formed would have been much higher. This was to be avoided, however, as it would have interfered seriously with the removal of sulphur.

The results of dry concentration show first that sulphur cannot be entirely eliminated. By careful adjustment of the separating machine about 25 per cent. of the total sulphur in the crude can be got rid of with the tails, without undue loss of iron; but if it is attempted to remove more than this amount the magnetic fields would require to be weakened to a point where considerable magnetite would be lost. It will be noted that sulphur was more easily got rid of in the separation of the larger-sized material. The concentration of the 40-mesh material increased the sulphur from 2.21 to 2.41 per cent., whereas concentration of the 4-mesh size reduced the sulphur from 2.00 to 1.07 per cent. This is accounted for by the fact that smaller particles of pyrrhotite are by reason of their weight more strongly influenced than larger particles and hence pass into the heads more readily. The phosphorus on the other hand is reduced considerably, more so than is actually necessary. However, this element is characterized in the best ores by its presence in very small amounts, and an extremely low phosphorus ore finds a ready market. The percentage of iron in the final concentrates is hardly 10 per cent. higher than that of the crude, although the percentage of insoluble matter was reduced by more than one-half. This is rather disappointing as a higher iron content was expected and would enhance considerably the value of the concentrates. Finer crushing might have raised the iron content, but at the same time would have undoubtedly raised the percentage of sulphur. In this connection it is interesting to note that concentrates from the 40-mesh crude were not only higher in sulphur, but also lower in iron than the concentrates from the 20-mesh crude, showing that dust particles are a serious detriment to clean separation.

The sieve test on the dry concentrates proves that 22 per cent. of the material is finer than 80-mesh, so that, apart from the high sulphur content, the concentrates are

not in condition for economical smelting. Nodulizing these concentrates would undoubtedly reduce the sulphur to probably 0.05 per cent. or under, and at the same time agglomerate the fine material.

Recapitulation of the results of dry concentration indicates a saving of over 98 per cent. of the original magnetite. This is due to the small ratio of concentration; only 1.187 units of crude being required to produce 1 unit of concentrate. By increasing this ratio, *i.e.*, allowing more magnetite to escape with the tails, it is probable that a higher grade concentrate would result. The percentage of loss allowable is, however, a function of the cost of the crude, so that in the commercial separation of this ore the mining costs would be an important factor in determining the grade of concentrates produced.

Concentration by means of the wet process yielded a heads product higher in iron, lower in gangue, sulphur practically the same, and with a trace of phosphorus. The 20-mesh material gave a slightly better concentrate than was obtained from the 10-mesh size, although a better saving was effected in separating the larger material. The recapitulation for sample No. 1 proved a saving of over 96 per cent. of the original magnetite, with a loss of 2.8 per cent. in the tailings and less than 1 per cent. loss in slimes.

The concentrates produced by the wet process of separation would require briquetting or nodulizing, and it is probable that the amount of desulphurizing required would have a distinct effect upon the output of either the briquetting furnace or nodulizing kiln.

Test No. 4.—Calabogie

Calabogie is a fairly good representation of many of the low-grade magnetites found along the Kingston and Pembroke railway. The ore is crystalline, exhibiting a somewhat schistose structure, and consists of fine-grained magnetite, green hornblende, quartz and calcite, with a little dark colored mica. Sulphur is present in the form of iron pyrites, but very little pyrites can be seen in hand specimens, and the crude contains only 0.139 per cent. of that obnoxious element. Phosphorus is present to the extent of 0.17 per cent., and is apparently intimately associated with the magnetite, as its removal is not easily accomplished.

Crushing to 1-6 inch was accomplished without difficulty, the proportion of fines passing a 40-mesh screen being a little over 30 per cent., leaving over 51 per cent. larger than 10-mesh, a result similar to that obtained in crushing Coe Hill, and as in the case of Coe Hill the sulphur was found to be concentrated to some extent in the 40-mesh material.

Dry concentration resulted in obtaining a non-Bessemer concentrate, phosphorus in the heads product being reduced to 0.099 per cent. from 0.17 per cent. in the crude, a total reduction of only 42 per cent. Sulphur was almost entirely eliminated. The iron was increased to a little over 62 per cent., but this was accomplished only by close adjustment of the separating machine and by making a large middling product to be returned to the crushers and then re-concentrated, the practical effect of which was to make a final concentrate containing over 28 per cent. of material fine enough to pass a 100-mesh screen. Hence nodulizing would be necessary to put these concentrates in shape for furnace use.

Recapitulation of the dry tests shows a saving of over 95 per cent. It would be possible to lower this saving to say 90 per cent. and obtain a concentrate higher in iron, but it is doubtful if phosphorus could be reduced to within the bessemer limit, and of course a reduction in the percentage of magnetite saved means increased cost per ton of product.

Wet separation of the crude yielded a much better heads product. By this method the phosphorus was reduced to 0.04, and the iron raised to 62.81 per cent. making a first-class bessemer concentrate. It will be noted that crushing to 20-mesh was sufficient to effect considerable reduction of phosphorus. Crushing to 40-mesh raised the iron to a little over 1 per cent. higher, but did not have any additional effect in the reduction of phosphorus. If it were desired to make a very high iron and low phosphorus concentrate, it is probable that tube mill grinding to 60-mesh would be necessary.

Recapitulation for sample 3, shows a saving of original magnetite of over 96 per cent., being 1 per cent. higher than the saving effected in dry work. Concentrates produced by the wet process would require either briquetting or nodulizing, and as practically no desulphurizing is necessary, the capacity of the furnace or kiln could be kept at a maximum.

Test No. 5.—Radnor

Radnor ore in physical characteristics differs radically from all the other ores tested. The ore treated is essentially a granitic gneiss impregnated with coarse granular magnetite, the gangue consisting of quartz, feldspar and hornblende. Both sulphur and phosphurus are present in approximately equal amounts, the percentages being 0.171 and 0.172 respectively. Very little pyrites can be seen in hand specimens, and apatite cannot be distinguished at all by the naked eye.

As would be expected from its granular structure the ore is easily disintegrated by crushing to 1-6 inch, forming a little over 28 per cent. of material fine enough to pass a 40-mesh screen, leaving 56 per cent. of the crushed, larger than 10-mesh. Sizing had apparently very little influence upon sulphur distribution, the sulphur content of the fines being about the same as that of the coarse.

With dry separation no difficulty was experienced in obtaining a high-grade Bessemer concentrate, the iron content of the heads being over 67 per cent., with sulphur at 0.033 per cent., and a trace of phosphorus. Recapitulation shows a saving of nearly 92 per cent. of the original magnetite, a result that should be approximated, if not equalled in commercial work. In the separation of this ore, the general method of making a middling product to be re-crushed and re-separated was followed throughout. On an average this middling product equalled 15 per cent. of the original crude, the retreatment resulting in making additional fine concentrates. If it were desired to make a final concentrate that could be smelted directly without nodulizing, it would be possible to reduce the re-treatment of middlings to say 10 per cent. or less of the original ore, thereby avoiding additional crushing and making less fines. This would, of course, yield a concentrate lower in iron, but it would still probably be within the bessemer limit.

Wet separation produced concentrates of slightly better grade with less loss of magnetite in the tailings, the percentage of magnetite saved being correspondingly higher. This is an item of some importance, for a slight difference in the saving of original magnetite will constitute an appreciable factor in the final cost sheets, more especially if the cost of crude delivered to the mill is relatively high.

Concentrates produced by the wet process will naturally require briquetting or nodulizing, but in this case, as in Calabogie, no desulphurization is required.

Briquetting and Desulphurization Tests

It has been pointed out in preceding pages that magnetic iron ore concentrates may be unfit for direct use in the blast furnace on account of their finely-divided character. Sometimes, also, these concentrates, although high in iron, contain too much sulphur to satisfy the furnaceman, and must therefore undergo a process of desulphurization.

When, therefore, the concentrates are finely divided, or contain an objectionable amount of sulphur, it is necessary that they should be briquetted or nodulized. Both the briquetting and nodulizing processes are efficient for the removal of sulphur, and, when carried out under proper conditions, will yield hard, porous briquettes or nodules, an ideal raw material for the blast furnace.

In order to show that the concentrates produced in the preceding tests were amenable to the briquetting and desulphurization process, experiments were carried out with samples of each of the concentrated ores. These briquetting tests were of necessity made on a small scale, and although they were extremely simple and lacked any elaborate details, they nevertheless prove that under proper conditions it is possible to briquette and desulphurize these concentrates without any added binder.

For the making of these tests the writer had no briquetting press or briquetting furnace, and was forced to utilize such apparatus as he had at hand. A die for forming the briquettes was made by boring a one-inch hole through a three-inch cube of cast iron, a plunger for this die being turned up out of mild steel, and fitted accurately to the bore hole. The briquettes were made by filling the die with slightly water-moistened concentrates, inserting the plunger and applying a pressure of 5,000 pounds to the square inch in a Reihke testing press. Briquettes made in this way were quite hard enough to stand ordinary handling, and were then taken to the briquetting furnace.

The furnace used consisted of an old gasoline assay furnace, fitted up with temporary bridge wall and roof, after the ordinary reverberatory type. The fuel consumed was gasoline, and although the capacity of this furnace was small and the temperature difficult of regulation, it answered fairly well. Some time was occupied in making preliminary experiments, with the view of ascertaining the range and extent of temperature required. It was possible to force the temperature of this little furnace to 1,450° C., but this degree of heat was seldom obtained during the experiments, as it was found unnecessary, a temperature of from 1,300° to 1,350° C. being quite sufficient for all purposes.

For the control and regulation of the heat Seger cones were utilized. These cones do not permit of any nice heat adjustment, but they were sufficiently accurate for the work at hand.

About eight hours' treatment in the furnace was found necessary for the production of well oxidized briquettes, the temperature during that time being gradually raised from the normal temperature of the laboratory to a final temperatnre of 1,300° or 1,350° C. After a few preliminary trials it was discovered that the heat should be raised very slowly for the first five or six hours, in order to effect a more or less complete peroxidation of the magnetite before sintering took place. When the heat was raised too quickly at the commencement of a test, a thin skin of magnetite sintered upon the outside of tbe briquette, effectively preventing oxidation of the interior, and, of course, putting an end to desulphurization. As stated previously, no nice temperature adjustment could be made. However, after the briquettes had reached a dull red heat, the temperature was elevated in steps of about 120° C. every hour, until a final temperature of 1,300° to 1,400° C. was attained; the furnace was held at this temperature for the space of an hour or so, then cooled down and the briquettes removed.

The briquettes made in the manner described above were found to be quite hard, and extremely porous. Oxidation had been carried to such an extent that no magnetism was displayed when tested with an ordinary six-inch steel horse-shoe magnet. Time did not permit of making any porosity tests, but it may be stated that tbe briquettes made from Temagami and Moose Mountain concentrates of 100-mesh fineness were so porous that they would absorb water like a piece of lump sugar.

For the making of briquettes of this size, 2½ inches long by 1 inch in diameter, from Temagami, Moose Mountain, Calabogie and Radnor concentrates, no excessive

treatment in the furnace was found necessary. Eight hours' time was sufficient to form well-oxidized and thoroughly desulphurized briquettes from the above concentrates. In the case of Coe Hill concentrates, which contained $1\frac{1}{2}$ per cent. of sulphur, a longer exposure in the furnace was necessary, and accordingly briquettes of these concentrates received about ten hours' treatment.

Following are the analyses of the raw concentrates and the briquettes. It should be kept in mind that the concentrates were analyzed for soluble iron, and insoluble residues, whereas the briquettes were analyzed for total iron and silica.

	Concentrates.				Briquettes.			
Locality.	Iron.	Insoluble.	Sulphur.	Phos.	Iron.	Silica.	Sulphur.	Phos.
Temagami	64.77	9.73	Trace	0.007	63.60	8.50	Trace	0.006
Moose Mountain	64.62	9.02	0.02	0.008	63.86	8.07	Trace	0.006
Coe Hill	64.43	8.68	1.54	Trace	60.25	5.72	0.051	Trace
Calabogie	62.81	7.02	Trace	0.04	60.15	3.15	Trace	0.038
Radnor	69.98	2.49	0.02	0.006	65.92	1.89	Trace	0.005

General Conclusions

Considering the experiments as a whole, it has been demonstrated that first-class bessemer concentrates (with one exception) can be produced from the crude ores submitted for testing purposes, and it has been shown that all of these concentrates will form hard porous briquettes, more or less peroxidized and free from sulphur, when submitted to a process similar to the Gröndal system of briquetting.

The extent of crushing required to produce these concentrates varies from relatively coarse disintegration, to a fine degree of pulverization, and is governed entirely by the physical structure of the ores treated. With coarse granular magnetites of the Radnor type, concentration was accomplished without excessive grinding, and it may be safe to add that ores of similar character will yield similar results. Fine-grained cryptocrystalline ores of the Temagami and Moose Mountain types required grinding to 40- or 60-mesh, followed by preliminary separation, and subsequently a re-grinding to 100-mesh, with re-concentration of the preliminary heads before yielding a high-grade product. Ores of an intermediate crystallization, represented by Calabogie and Coe Hill, may be concentrated effectively by crushing to 40-mesh or thereabouts.

Sulphur, when present in the form of iron pyrites, FeS_2, can, in the majority of cases, be reduced to a very low figure in the concentrate. If present as pyrrhotite Fe_7S_8, its removal is difficult, and the best that can be expected is to produce a concentrate of sulphur content very little lower than the original percentage contained in the crude. If subsequent briquetting or nodulizing of the fines is required, almost complete oxidation of the sulphur will result, but the capacity of the briquetting furnace or nodulizing kiln will depend upon the extent of desulphurization desired.

No trouble was experienced in the removal of phosphorus below the bessemer limit. It is true that none of the ores tested would be considered high phosphorus, compared, for instance, with Port Henry magnetites;[4] but, so far as the knowledge of the writer extends, no magnetites of similar high phosphorus content are found in Ontario.

Dry concentration, with ores of Temagami and Moose Mountain character, will yield indifferent results, the chief obstacle being the effective removal of mechanically-entangled dust-particles, that render the production of high-grade concentrates very difficult, if not impossible. Jaspilyte ores will yield a fairly coarse-grained silicious concentrate, but require fine grinding, and the application of the wet process of separation, for a high-grade bessemer product. Fine-grained compact magnetites, similar to Moose Mountain, will not yield even a fair silicious concentrate unless pulverized to 60-mesh, and, like the jaspilyte ores, require additional grinding with wet separation before yielding bessemer concentrates.

[4] 17th Rep. Bur. Min., 1908, p. 245

Ores similar to Coe Hill, containing much magnetic pyrites, but with low phosphorus content, are amenable to either dry or wet methods of separation, but sulphur will not be reduced materially, and the resulting concentrates must be desulphurized. Such high sulphur concentrates can be handled by either the Gröndal briquetting furnace or the nodulizing kiln, but, as stated previously, the capacity of either process will depend upon the extent of desulphurization desired.

Magnetites of a schistose structure, similar to Calabogie, containing no excessive amounts of sulphur and phosphorus, are amenable to dry separation for the production of non-bessemer concentrates, but will yield a bessemer product with grinding to 40-mesh and subsequent application of the wet process.

Coarsely crystalline ores of the Radnor type, containing no excessive percentages of sulphur and phosphorus, will readily yield a high grade bessemer concentrate, with either the dry or wet process, and will not require excessive grinding.

The Question of Cost

With experimental tests of this character it is impossible to arrive, within any degree of accuracy, at conclusions regarding costs of operation. As a general rule, it may be stated that costs of production will vary inversely with the scale of operations and the iron content of the ore treated, and directly as the cost of the crude delivered, and the extent of crushing required. The heaviest items will, in the majority of cases, be the cost of mining or quarrying the crude, and the cost of crushing for subsequent separation. In the case of many eastern Ontario deposits, the heaviest item will undoubtedly be mining cost, the extent of crushing required not being excessive. With ores of the Temagami and Moose Mountain types, crushing costs will run high, but as the deposits are of sufficient magnitude to permit of cheap mining, costs under this head should be comparatively low.

Reliable data pertaining to costs of crushing are difficult to obtain, and, when obtained, are uncertain in application to specific problems. For the reason that different ores are of widely different physical structure, it has been stated that crushing costs may be estimated at the rate of one cent per mesh, 20 cents per ton for 20-mesh, 60 cents for 60-mesh and $1.00 per ton for 100-mesh. The writer has had no experience in the application of this schedule, but, in so far as he can learn, it tallies approximately with the costs of crushing ores of average hardness.

[5]That the process of magnetic separation applied to the concentration of low grade Ontario iron ores is worthy of serious consideration cannot be doubted, and it is not too much to say that the outlook for the establishment of such an industry in Ontario is encouraging. Our blast furnaces are forced to operate with high-priced fuel imported from the United States, and, in the majority of instances, are burdened with an ore mixture that yields not more than 55 per cent. of pig iron. Over 70 per cent. of the iron ore smelted in Ontario furnaces is imported from the United States, due to the fact that native mines cannot supply the demand for either foundry or bessemer ores; indeed, at the time of writing there is but one Ontario mine producing bessemer iron ore, and in limited quantity.

That the production of high grade briquetted or nodulized bessemer concentrates would find a ready market there can be no doubt, and if a price of five to six dollars per gross ton for this material could be secured and maintained, there should be a comfortable margin of profit above the costs of production and transportation.

The writer wishes to make grateful acknowledgment of the assistance and advice rendered by the following members of the faculty of the Kingston School of Mines: L. W. Gill, Professor of Electrical Engineering; J. C. Gwillim, Professor of Mining Engineering; S. F. Kirkpatrick, Professor of Metallurgy, and Mr. George McKay.

[5] Magnetic Separation. By F. T. Snyder, Journal Canadian Mining Institute, Vol. VII

SIEVE TEST ON TEMAGAMI DRY CONCENTRATES.

Showing Distribution of Material According to Mesh Size.

Concentrates from Sample.	Weight, Pounds.	Per Cent. Pass, 100 Mesh.	Per Cent. Pass, 80 Mesh.	Per Cent. Pass, 60 Mesh.	Per Cent. Pass, 40 Mesh.	Per Cent. Pass, 20 Mesh.	Per Cent. Pass, 10 Mesh.	Per Cent. Over, 10 Mesh.
1	334	57.80	7.30	8.80	26.10	....	....	....
2	131	6.20	1.60	4.70	11.10	76.10	....	....
3	456	4.69	2.08	2.08	4.69	25.55	60.91	....
4	634	3.12	1.55	1.02	3.62	6.21	33.33	51.10
5	740	3.11	1.03	0.52	2.07	8.33	8.81	76.10
Total Averages...	2,295	6.97	2.54	2.19	11.65	13.59	24.23	38.80

Mill Log of Test No. 1 on Temagami Crude.

Weight of Sample Received 5780 Pounds; Broken in Blake Crusher to 1 inch, thence to Cornish Rolls Crushing to 1-6th inch.

Sampled (A).

3787 Pounds to Dry Test

Impact Screen

Oversize

Sample 1. Mesh 40.

Oversize

Sample 2. Mesh 24.

Oversize

Sample 3. Mesh 12.

Oversize

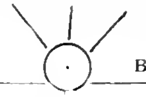
Sample 4. Mesh 8.

Sample 5. Mesh 6.

Analyses of Sample A.

	Iron.	Magnetite.	Insoluble.	Sulphur.	Phosphorus.	Titanium.
Per Cent.	37.04	51.14	47.26	0.062	0.032	0.00

1993 Pounds to Wet Test



BALL MILL

Sample 1. Mesh 20.

Sample 2. Mesh 40.

DRY CONCENTRATION.

Sample Number.	Through Mesh.	Crude Ore. Weight and Per Cent. Pounds.	Crude Ore. Per Cent.	Crude Ore. Analyses. Iron, Per Cent.	Magnetite, Per Cent.	Insoluble, Per Cent.	Sulphur, Per Cent.	Concentrates. Weight and Per Cent. Pounds.	Per Cent.	Concentrates. Analyses. Iron, Per Cent.	Magnetite, Per Cent.	Insoluble, Per Cent.	Sulphur, Per Cent.	Phosphorus, Per Cent.	Tailings. Weight and Per Cent. Pounds.	Per Cent.	Tailings. Analyses. Iron, Per Cent.	Magnetite, Per Cent.	Sulphur, Per Cent.	Dust Loss. Pounds.	Per Cent.	Efficiency. Per Cent. of Magnetite Saved.	Per Cent. of Magnetite Lost.	Units of Crude per Unit of Concentrate.
1	40	715	18.89	31.24	43.04	53.46	......	331	46.7	56.23	77.64	23.88	Trace	0.053	346	48.4	9.25	12.77	......	35	4.8	83.20	16.80	2.11
2	24	224	5.92	37.10	51.23	46.54	......	131	58.5	53.93	74.37	28.16	Trace	0.053	88	39.3	13.69	18.90	......	5	2.2	81.89	15.11	1.71
3	12	735	19.40	38.22	52.77	44.82	......	456	62.1	52.51	72.52	26.10	Trace	0.053	270	36.7	15.01	20.85	......	9	1.2	85.35	14.65	1.61
4	8	958	25.29	38.95	53.78	43.32	......	634	66.2	50.87	71.11	28.78	Trace	0.058	315	32.9	11.60	20.16	......	9	0.9	87.56	12.14	1.51
5	6	1,155	30.49	37.60	51.92	44.16	......	740	64.1	50.51	70.28	30.15	Trace	0.061	404	34.9	11.13	19.51	......	11	0.9	86.77	13.23	1.56
Totals		3,787	100.00	36.85	50.88	47.10	......	2,295	60.6	52.04	71.85	27.6	Trace	0.056	1,123	37.6	13.18	18.18	......	69	1.8	86.05	13.95	1.611

RECAPITULATION:

Pounds Magnetite in Crude 1926.82
" " Concentrate 1618.96
" " Tailings 258.70
" " Dust...... .... 19.16
Total....................................1926.82

Per Cent. Saved in Concentrate................................ 85.578
" Lost in Tailings................................ 13.426
" Lost in Dust 0.996
Total................................ 100.000

WET CONCENTRATION.

Sample Number.	Ground to Mesh.	Crude Ore. Weight in Pounds.	Crude Ore. Analyses. Iron, Per Cent.	Magnetite, Per Cent.	Insoluble, Per Cent.	Sulphur, Per Cent.	Phosphorus, Per Cent.	Concentrates. Weight and Per Cent. Pounds.	Per Cent.	Concentrates. Analyses. Iron, Per Cent.	Magnetite, Per Cent.	Insoluble, Per Cent.	Sulphur, Per Cent.	Phosphorus, Per Cent.	Tailings. Weight and Per Cent. Pounds.	Per Cent.	Tailings. Analyses. Iron, Per Cent.	Magnetite, Per Cent.	Sulphur, Per Cent.	Slime Loss. Pounds.	Per Cent.	Efficiency. Per Cent. of Magnetite Saved.	Per Cent. of Magnetite Lost.	Units of Crude per Unit of Concentrate.
1	20	1008	37.04	51.14	47.26	0.062	0.032	596	59.15	54.00	74.59	23.62	Trace	0.037	346	31.35	12.12	16.73	......	66	6.5	85.78	13.22	1.68
2	40	985	37.04	51.14	47.26	0.062	0.032	......	......	55.46	76.58	22.72	Trace	0.035	......	......	......	......	......	......	......	......	......	......
2e	60	......	55.46	76.58	22.72	Trace	0.035	......	......	59.87	82.67	15.67	Trace	0.015	......	......	......	......	......	......	......	......	......	......
2ee	100	......	59.87	82.67	15.67	Trace	0.015	476	18.1	61.77	89.44	9.73	Trace	0.007	422	12.8	10.74	14.83	......	57	5.8	85.31	14.69	2.06

RECAPITULATION FOR SAMPLE No. 2—2ee:

Pounds Magnetite in Crude 503.719
" " Concentrate...................425.734
" " Tailings 45.823
" " Slimes 32.642
Total 503.719

Per Cent. Saved in Concentrate 84.519
" Lost in Tailings.... .... 8.997
" Lost in Slimes................................ 6.484
Total 100.000

SIEVE TEST ON CALABOGIE DRY CONCENTRATES.

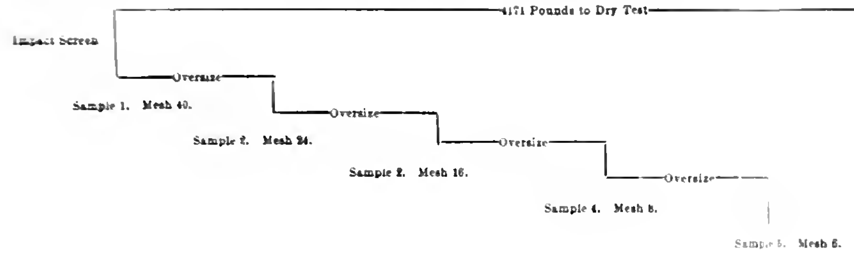
Showing Distribution of Material According to Mesh Size.

Concentrates from Sample.	Weight, Pounds.	Per Cent Pass, 100 Mesh.	Per Cent. Pass, 80 Mesh.	Per Cent. Pass, 60 Mesh.	Per Cent. Pass, 40 Mesh.	Per Cent. Pass, 20 Mesh.	Per Cent. Pass, 10 Mesh.	Per Cent. Over, 10 Mesh.
1	711	40.60	19.70	6.55	33.15	....	....	....
2	215	13.11	4.25	3.11	15.93	61.60	....	....
3	290	11.25	5.00	3.75	8.48	45.00	26.60	....
4	952	11.98	4.69	2.60	6.75	34.65	32.50	5.00
5	585	13.96	4.69	2.79	2.43	25.14	30.95	9.79
Total Averages...	2,753	19.84	6.75	3.78	15.70	27.53	20.00	3.61

Mill Log of Test No. 4, on Calabogie Crude.

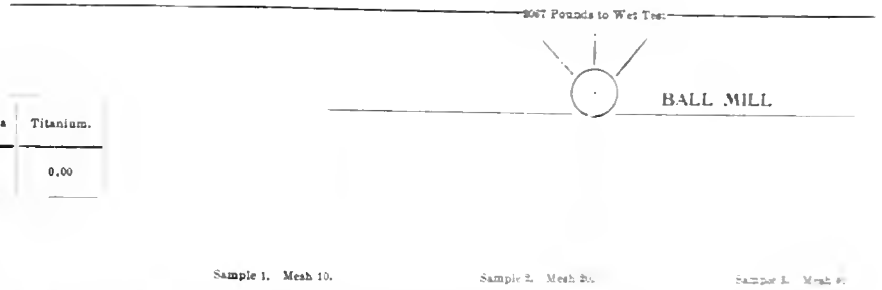
Weight of Sample Received 6280 Pounds; Broken in Blake Crusher to 1 Inch, thence to Cornish Rolls Crushing to 1-6th Inch.

Sampled (A.)



Analysis of Sample A.

	Iron.	Magnetite.	Insoluble.	Sulphur.	Phosphorus.	Titanium.
Per Cent.	41.89	57.66	25.18	0.139	0.17	0.00



DRY CONCENTRATION.

CRUDE ORE.								CONCENTRATES.							TAILINGS.					DUST LOSS.		EFFICIENCY.		
		Weight and Per Cent.		Analyses.				Weight and Per Cent.		Analyses.					Weight and Per Cent.		Analyses.							
Sample Number.	Through Mesh.	Pounds.	Per Cent.	Iron, Per Cent.	Magnetite, Per Cent.	Insoluble, Per Cent.	Sulphur, Per Cent.	Pounds.	Per Cent.	Iron, Per Cent.	Magnetite, Per Cent.	Insoluble, Per Cent.	Sulphur, Per Cent.	Phosphorus, Per Cent.	Pounds.	Per Cent.	Iron, Per Cent.	Magnetite, Per Cent.	Sulphur, Per Cent.	Pounds.	Per Cent.	Per Cent of Magnetite Saved.	Per Cent of Magnetite Lost.	Units of Crude per Unit of Concentrate.
1	40	1,281	30.72	37.87	51.43	28.10	0.134	711	55.6	64.32	88.82	8.53	Trace	0.08	504	39.3	3.39	4.55	......	66	5.1	95.94	4.06	1.8
2	24	315	7.55	44.83	61.78	22.26	0.115	215	68.3	62.9	86.85	8.25	Trace	0.09	65	20.9	5.57	7.69	......	15	4.7	96.32	3.68	1.46
3	16	412	9.88	45.97	63.39	21.26	0.063	290	70.4	62.12	85.77	8.88	Trace	0.10	109	26.45	7.65	10.56	......	13	3.15	95.28	4.72	1.42
4	8	1,343	32.18	45.33	63.84	31.46	6.06	952	70.8	61.58	84.92	8.84	Trace	0.11	350	26.00	7.80	10.85	......	41	3.20	95.08	4.92	1.41
5	6	820	19.66	45.20	63.34	33.00	0.067	585	71.4	60.06	82.92	10.35	Trace	0.11	209	25.5	7.96	11.00	......	26	3.10	95.02	4.98	1.40
Totals	......	4,171	100.00	43.00	59.38	33.84	0.086	2,753	65.99	62.08	85.73	9.08	Trace	0.099	1,257	30.18	5.80	8.09	......	161	3.80	95.29	4.71	1.515

RECAPITULATION:

Pounds Magnetite in Crude.................................2476.31
" " Concentrate..........2360.4
" " Tailings..........101.8
" " Dust..........14.14
Total..........2476.34

Per Cent. Saved in Concentrate.......................... 95.318
" Lost in Tailings.......................... 4.111
" Lost in Dust.......................... 0.571
Total..........................100.000

WET CONCENTRATION.

CRUDE ORE.										CONCENTRATES.					TAILINGS.					SLIME LOSS.		EFFICIENCY.		
			Analyses.					Weight and Per Cent.		Analyses.					Weight and Per Cent.		Analyses.							
Sample Number.	Ground to Mesh.	Weight in Pounds.	Iron, Per Cent.	Magnetite, Per Cent.	Insoluble, Per Cent.	Sulphur, Per Cent.	Phosphorus, Per Cent.	Pounds.	Per Cent.	Iron, Per Cent.	Magnetite, Per Cent.	Insoluble, Per Cent.	Sulphur, Per Cent.	Phosphorus, Per Cent.	Pounds.	Per Cent.	Iron, Per Cent.	Magnetite, Per Cent.	Sulphur, Per Cent.	Pounds.	Per Cent.	Per Cent of Mag in the Saved	Per Cent of Mag in the Lost	Units of Crude per Unit of Concentrate
1	10	673	41.89	57.66	25.18	0.139	0.17	437	64.9	67.65	79.61	11.16	Trace	0.11	202	30.0	12.36	17.06	......	34	5.1	[illegible]	12.34	[illegible]
2	20	699	41.89	57.66	25.18	0.139	0.17	439	62.8	61.59	85.04	9.17	Trace	0.04	211	30.2	5.64	11.92	......	49	7.0	92.76	7.24	[illegible]
3	40	695	41.69	57.66	25.18	0.139	0.17	445	64.02	62.81	86.73	7.02	Trace	0.04	157	26.9	4.04	5.57	......	83	9.36	96.43	3.57	[illegible]

RECAPITULATION FOR SAMPLE No. 3:

Pounds Magnetite in Crude..............................100.737
" " Concentrate..........85.946
" " Tailings..........10.416
" " Slimes..........4.374
Total..........................100.737

Per Cent. Saved in Concentrate.......................... [illegible]
" Lost in Tailings.......................... [illegible]
" Lost in Slimes.......................... [illegible]
Total.......................... 100.000

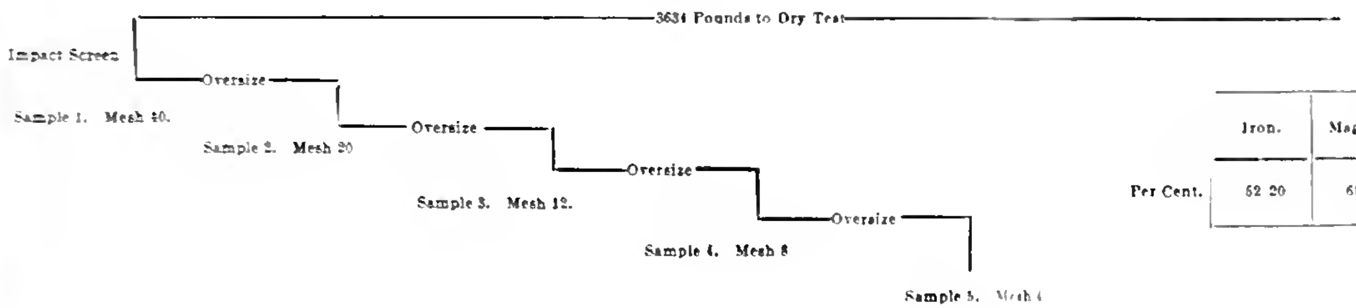
SIEVE TEST ON COE HILL DRY CONCENTRATES,
Showing Distribution of Material according to Mesh Size.

Concentrates from Sample.	Weight, Pounds.	Per Cent. Pass. 100 Mesh.	Per Cent. Pass. 80 Mesh.	Per Cent. Pass. 60 Mesh.	Per Cent. Pass. 40 Mesh.	Per Cent. Pass. 20 Mesh.	Per Cent. Pass. 10 Mesh.	Per Cent. Over. 10 Mesh.
1	535	41.65	13.01	9.38	35.96	....	....	....
2	263	9.38	4.16	3.11	15.62	67.70	....	....
3	312	10.93	4.69	3.12	10.41	32.29	38.55	....
4	347	6.75	3.12	2.08	6.25	18.42	36.45	27.00
5	1,280	5.70	2.33	1.94	4.26	11.65	24.61	49.51
Total Averages..	3,037	16.62	5.72	4.21	14.67	16.22	18.50	24.03

Mill Log of Test No. 3, on Coe Hill Crude.

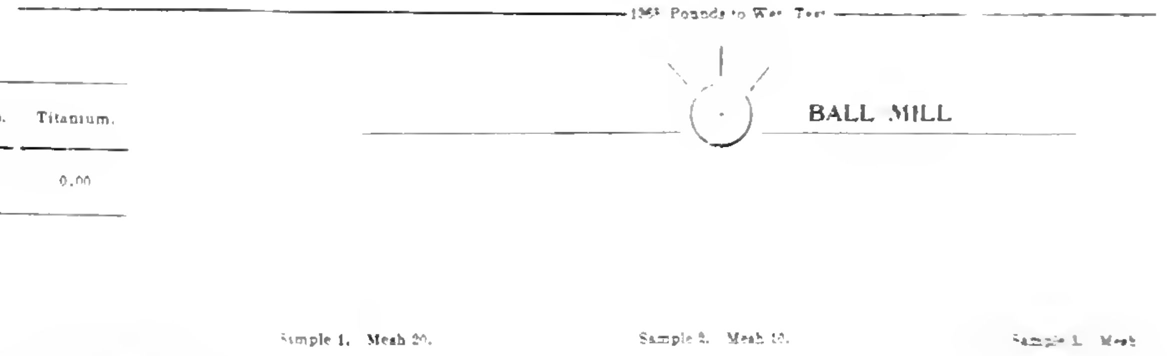
Weight of Sample Received 5602 Pounds; broken in Blake Crusher to 1 inch, thence to Cornish Rolls crushing to 1-4 inch.

Sampled (A.)



Analysis of Sample A.

	Iron.	Magnetite.	Insoluble.	Sulphur.	Phosphorus.	Titanium.
Per Cent.	52.20	68.46	22.18	1.71	0.03	0.00



DRY CONCENTRATION.

Sample Number.	Through Mesh.	Crude Ore: Pound.	Crude Ore: Per Cent.	Crude Ore Analyses: Iron, Per Cent.	Magnetite, Per Cent.	Insoluble, Per Cent.	Sulphur, Per Cent.	Concentrates: Pounds.	Concentrates: Per Cent.	Concentrates Analyses: Iron, Per Cent.	Magnetite, Per Cent.	Insoluble, Per Cent.	Sulphur, Per Cent.	Phosphorus, Per Cent.	Tailings: Pounds.	Tailings: Per Cent.	Tailings Analyses: Iron, Per Cent.	Magnetite, Per Cent.	Sulphur, Per Cent.	Dust Loss: Pounds.	Dust Loss: Per Cent.	Efficiency: Per Cent. of Magnetite Saved.	Per Cent. of Magnetite Lost.	Units of Crude per Unit of Concentrate.
1	40	1,103	30.35	47.97	61.56	27.16	2.21	535	75.6	61.83	80.80	9.71	2.41	0.003	231	21.2	5.41	3.88	1.72	34	3.1	98.81	1.19	1.32
2	20	310	8.52	54.24	71.77	20.05	1.48	263	84.9	63.56	83.97	7.80	1.79	0.001	40	12.9	8.61	1.50	3.50	7	2.2	99.16	0.84	1.18
3	12	356	9.80	55.08	72.42	19.70	1.72	312	87.6	61.88	82.36	9.56	1.46	0.004	38	10.7	8.01	2.76	3.89	6	1.7	99.78	0.32	1.11
4	8	393	10.81	54.40	71.44	21.00	1.74	347	88.3	59.72	79.91	11.78	1.21	0.002	42	10.7	11.64	7.02	4.00	4	1.0	98.98	1.02	1.13
5	4	1,472	40.51	54.57	71.13	21.78	2.00	1,280	87.0	60.15	80.81	11.81	1.07	0.002	183	12.4	10.08	7.25	3.09	9	0.6	98.56	144	1.15
Totals		3,634	100.00	52.84	68.83	23.00	1.96	3,037	83.6	61.03	80.99	10.61	1.55	0.002	537	14.8	7.09	4.21	2.64	60	1.6	99.13	0.87	1.187

RECAPITULATION:

Pounds Magnetite in Crude........................ .... 2,501.28.
" " Concentrate.................. 2,459.66
" " Tailings.................... 22.61
" " Dust.......................... 18.01
Total..................................... 2,501.28

Per Cent. Saved in Concentrate.............................. 98.336
" Lost in Tailings................ .... 0.903
" Lost in Dust.. 0.761
Total... .... 100.000

WET CONCENTRATION.

Sample Number.	Ground to Mesh.	Weight in Pounds.	Crude Ore Analyses: Iron, Per Cent.	Magnetite, Per Cent.	Insoluble, Per Cent.	Sulphur, Per Cent.	Phosphorus, Per Cent.	Concentrates Weight and Per Cent: Pounds.	Per Cent.	Concentrates Analyses: Iron, Per Cent.	Magnetite, Per Cent.	Insoluble, Per Cent.	Sulphur, Per Cent.	Phosphorus, Per Cent.	Tailings: Pounds.	Tailings: Per Cent.	Tailings Analyses: Iron, Per Cent.	Magnetite, Per Cent.	Sulphur, Per Cent.	Slime Loss: Pounds.	Slime Loss: Per Cent.	Efficiency: Per Cent. of Magnetite Saved.	Per Cent. of Magnetite Lost.	Units of Crude per Unit of Concentrate.
1	20	1,004	52.20	68.46	22.18	1.71	0.03	771	77.1	64.43	85.72	8.68	1.54	Trace	187	15.6	9.73	10.35	2.66	43	4.2	[illegible]	3.46	[illegible]
2	10	964	52.20	68.46	22.18	1.71	0.03	754	78.2	63.67	81.67	9.48	1.54	Trace	175	18.2	11.55	10.07	2.97	35	3.6	[illegible]	3.14	[illegible]
......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......

RECAPITULATION FOR SAMPLE No. 1:

Pounds Magnetite in Crude 687.337
" " Concentrate 663.347
" " Tailings........... .... 19.354
" " Slimes..... .... 1.636
Total 687.337

Per Cent. Saved in Concentrate.......... .... [illegible]
" Lost in Tailings.. .... 2.826
" Lost in Slimes.................................... [illegible]
Total... .... [illegible]

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SIEVE TEST ON RADNOR DRY CONCENTRATES

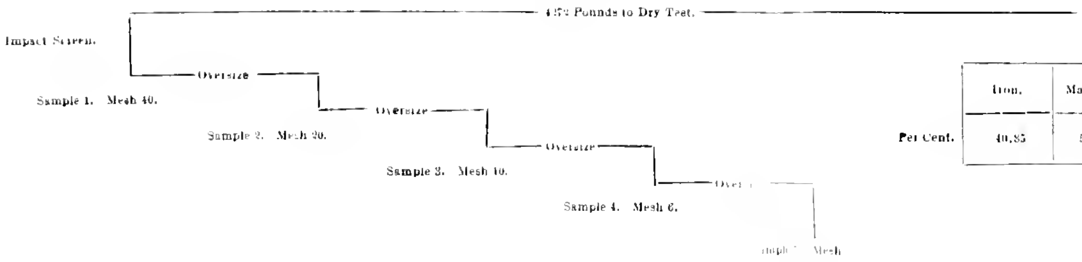
Showing Distribution of Material According to Mesh Size.

Concentrates from Sample.	Weight, Pounds.	Per Cent. Pass. 100 Mesh.	Per Cent. Pass. 80 Mesh.	Per Cent. Pass. 60 Mesh.	Per Cent. Pass. 40 Mesh.	Per Cent. Pass. 20 Mesh.	Per Cent. Pass. 10 Mesh.	Per Cent. Over. 10 Mesh.
1	645	33.37	14.58	10.43	41.62	....	....	....
2	349	2.08	1.55	1.03	8.34	86.50	....	....
3	754	3.25	3.12	3.12	9.36	48.85	32.30	....
4	677	8.33	4.16	3.12	11.45	29.19	25.00	18.75
5								
Total averages.	2,425	12.50	8.23	4.76	18.45	35.75	16.98	5.23

Mill Log of Test No. 5, on Radnor Crude.

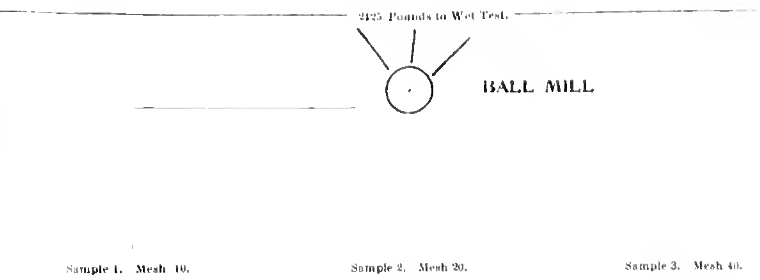
Weight of Sample Received 6397 Pounds, Broken in Blake Crusher to 1 inch, thence to Cornish Rolls Crushing to 1-6th inch.

Sampled (A.)



Analysis of Sample A.

	Iron.	Magnetite.	Insoluble.	Sulphur.	Phosphorus.	Titanium.
Per Cent.	40.85	56.20	39.55	0.171	0.172	0.00



DRY CONCENTRATION.

Sample Number.	Through Mesh.	Crude Ore: Pounds.	Crude Ore: Per Cent.	Crude Ore: Iron, Per Cent.	Crude Ore: Magnetite, Per Cent.	Crude Ore: Insoluble, Per Cent.	Crude Ore: Sulphur, Per Cent.	Concentrates: Pounds.	Concentrates: Per Cent.	Concentrates: Iron, Per Cent.	Concentrates: Magnetite, Per Cent.	Concentrates: Insoluble, Per Cent.	Concentrates: Sulphur, Per Cent.	Concentrates: Phosphorus, Per Cent.	Tailings: Pounds.	Tailings: Per Cent.	Tailings: Iron, Per Cent.	Tailings: Magnetite, Per Cent.	Tailings: Sulphur, Per Cent.	Dust Loss: Pounds.	Dust Loss: Per Cent.	Efficiency: Per Cent. of Magnetite Saved.	Efficiency: Per Cent. of Magnetite Lost.	Efficiency: Units of Crude per Unit of Concentrate.
1	40	1,208	28.25	39.23	53.96	39.04	0.170	645	53.4	69.21	95.55	3.15	0.01	Trace	520	43.1	[illegible]	6.44	0.35	43	3.5	94.69	5.31	1.87
2	20	632	14.80	41.99	47.82	35.43	0.150	349	55.2	68.75	94.89	1.21	0.03	Trace	269	42.6	8.98	12.01	0.32	14	2.2	90.67	9.33	1.81
3	10	1,253	29.37	43.67	60.09	35.92	0.170	754	60.1	66.63	91.96	6.07	0.04	Trace	481	38.1	9.09	12.11	0.37	18	1.1	92.19	7.81	1.66
4	6	1,179	27.58	41.99	57.77	36.43	0.175	677	57.4	65.92	90.98	9.00	0.05	Trace	492	41.8	9.12	12.62	0.33	10	0.8	90.50	9.50	1.74
Totals	......	4,272	100.00	41.72	57.60	37.12	0.168	2,425	56.75	67.42	93.09	5.82	0.033	Trace	1,762	41.24	7.95	10.97	0.345	85	1.98	91.77	8.23	1.761

RECAPITULATION:

Pounds Magnetite in Crude.............................2460.672
" " Concentrate........ .... 2257.432
" " Tailings................ 191.291
" " Dust..... .... 11.949
Total 2460.672

Per Cent. Saved in Concentrate.......... .... 91.742
" Lost in Tailings..... .... 7.759
" Lost in Dust.. 0.499
Total... 100.000

WET CONCENTRATION.

Sample Number.	Ground to Mesh.	Crude Ore: Weight in Pounds.	Crude Ore: Iron, Per Cent.	Crude Ore: Magnetite, Per Cent.	Crude Ore: Insoluble, Per Cent.	Crude Ore: Sulphur, Per Cent.	Crude Ore: Phosphorus, Per Cent.	Concentrates: Pounds.	Concentrates: Per Cent.	Concentrates: Iron, Per Cent.	Concentrates: Magnetite, Per Cent.	Concentrates: Insoluble, Per Cent.	Concentrates: Sulphur, Per Cent.	Concentrates: Phosphorus, Per Cent.	Tailings: Pounds.	Tailings: Per Cent.	Tailings: Iron, Per Cent.	Tailings: Magnetite, Per Cent.	Tailings: Sulphur, Per Cent.	Slime Loss: Pounds.	Slime Loss: Per Cent.	Efficiency: Per Cent of Magnetite Saved.	Efficiency: Per Cent. of Magnetite Lost.	Efficiency: Units of Crude per Unit of Concentrate.
1	10	665	40.85	56.20	39.55	0.171	0.172	382	57.40	66.78	92.12	6.95	0.08	0.007	219	37.40	5.9	7.70	0.37	34	5.2	94.21	5.79	1.74
2	20	678	40.85	58.20	39.55	0.171	0.172	378	55.8	68 81	94.99	3.75	0.01	0.004	261	38.4	5.95	7.70	0.43	39	5.8	94.43	5.57	1.79
3	40	782	40.85	58.20	39.55	0.171	0.172	427	54.6	69.98	98.61	2.49	0.02	0.006	300	38.4	5.81	7.55	0.39	55	7.0	93.94	6.06	1.83

RECAPITULATION FOR SAMPLE No. 3.

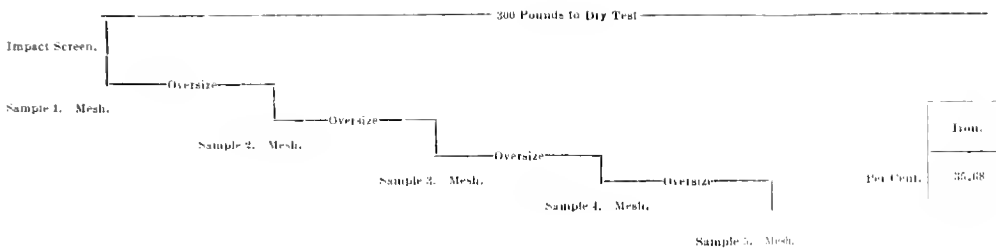
Pounds Magnetite in Crude...439.484
" " Concentrate 412.524
" " Tailings 22.650
" " Slimes..4.310
Total 439.484

Per Cent. Saved in Concentrate 93.865
" Lost in Tailings.... .... 5.153
" Lost in Slimes 0.982
Total 100.000

Mill Log of Test No. 2, on Moose Mountain Crude.

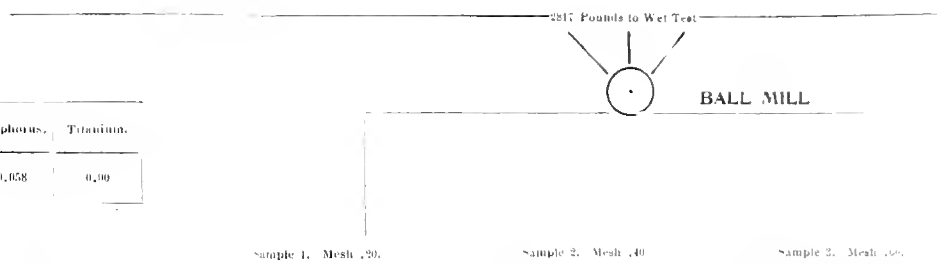
Weight of Sample Received 3,117 Pounds; broken in Blake Crusher to 1 inch, thence to Cornish Rolls crushing to 1-6 inch.

Sampled (A.)



Analysis of Sample A.

	Iron.	Magnetite.	Insoluble.	Sulphur.	Phosphorus.	Titanium.
Per Cent.	35.68	49.26	50.36	0.052	0.058	0.00



DRY CONCENTRATION.

		Crude Ore.						Concentrates.							Tailings.					Dust Loss.		Efficiency.		
		Weight and Per Cent.		Analyses.				Weight and Per Cent.		Analyses.					Weight and Per Cent.		Analyses.							
Sample Number.	Through Mesh.	Pounds.	Per Cent.	Iron. Per Cent.	Magnetite. Per Cent.	Insoluble. Per Cent.	Sulphur. Per Cent.	Pounds.	Per Cent.	Iron. Per Cent.	Magnetite. Per Cent.	Insoluble. Per Cent.	Sulphur. Per Cent.	Phosphorus. Per Cent.	Pounds.	Per Cent.	Iron. Per Cent.	Magnetite. Per Cent.	Sulphur. Per Cent.	Pounds.	Per Cent.	Per Cent. of Magnetite Saved.	Per Cent. of Magnetite Lost.	Units of Crude per Unit of Concentrate.
3	60	300	......	35.68	49.26	50.36	0.052	197	65.6	51.40	70.97	29.29	0.03	0.03	90	30.0	3.53	7.63	......	13	4.3	94.78	5.22	1.52
......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Totals	......	300	......	35.68	49.26	50.36	0.052	197	65.6	51.40	70.97	29.29	0.03	0.03	90	30.0	3.53	7.63	......	13	4.3	94.78	5.22	1.52

RECAPITULATION:

Pounds Magnetite in Crude 147.78
" " Concentrate 139.81
" " Tailings 6.86
" " Dust 1.11
Total 147.78

Per Cent. Saved in Concentrate 94.606
" Lost in Tailings 4.642
" Lost in Dust 0.752
Total 100.000

WET CONCENTRATION.

			Crude Ore.					Concentrates.							Tailings.					Slime Loss.		Efficiency.		
			Analyses.					Weight and Per Cent.		Analyses.					Weight and Per Cent.		Analyses.							
Sample Number.	Ground to Mesh.	Weight in Pounds.	Iron. Per Cent.	Magnetite. Per Cent.	Insoluble. Per Cent.	Sulphur. Per Cent.	Phosphorus. Per Cent.	Pounds.	Per Cent.	Iron. Per Cent.	Magnetite. Per Cent.	Insoluble. Per cent.	Sulphur. Per Cent.	Phosphorus. Per Cent.	Pounds.	Per Cent.	Iron. Per Cent.	Magnetite. Per Cent.	Sulphur. Per Cent.	Pounds.	Per Cent.	Per Cent. of Magnetite Saved.	Per Cent. of Magnetite Lost.	Units of Crude per Unit of Concentrate.
1	20	931	35.68	49.26	50.36	0.052	0.058	662	71.8	46.94	64.81	33.09	0.03	0.042	201	21.6	7.31	10.09	......	61	6.5	94.65	5.35	1.39
2	40	920	35.68	49.26	50.36	0.052	0.058	621	67.6	49.15	67.85	30.16	0.03	0.021	223	24.2	7.81	10.78	......	76	8.2	93.07	6.93	1.45
3	60	966	35.68	49.26	50.36	0.052	0.058	......	......	53.05	73.25	24.83	0.02	0.015	......	......	......	......	......	......	......	......	......	......
3a	100	......	53.05	73.25	24.83	0.02	0.015	490	50.7	64.62	89.23	9.09	0.02	0.008	371	38.1	5.86	8.23	......	105	10.8	91.85	8.05	1.97

RECAPITULATION FOR SAMPLE No. 3—3a:

Pounds Magnetite in Crude 475,851
" " Concentrate 437,227
" " Tailings 30,533
" " Slimes 8,091
Total 475,851

Per Cent. Saved in Concentrate 91.883
" Lost in Tailings 6.414
" Lost in Slimes 1.703
Total 100.000

LAKE SAVANT IRON RANGE AREA

BY E. S. MOORE

Introduction

The Lake Savant Iron Range seems to be a fitting term to apply to that range which extends more or less continuously for a considerable distance westward from the lower part of Lake Savant. The range is discontinuous in some places, but it can be traced by small outcrops and by deflections of the magnetic needle for a distance of about 25 miles, beginning on the islands near the western shore of Savant lake and reaching just beyond the southern end of Cliff lake.

A geological survey of the iron range and the surrounding area was made by the writer during the past summer while acting under the instructions of Mr. T. W. Gibson, Deputy Minister of Mines, and a map on a scale of two miles to an inch has been prepared to accompany this report. While in the field and also during the preparation of this report the "Map of the Routes Traversed by the National Transcontinental Railway between Lake Nipigon and Sturgeon Lake," prepared by Mr. W. H. Collins and published by the Canadian Geological Survey, has been found of very great service. Although more detailed work necessitated changes, the geological features and topography were found very accurately represented, considering the conditions under which the map had been prepared. The blue-prints of the trial lines run by the Grand Trunk Pacific Railway Company between lake Savant and Cliff lake, and later abandoned, have been obtained through the kindness of the chief engineer at Ottawa, and have been very useful in furnishing data for the accompanying map.

For many favors and much assistance in carrying on the work in the field, the writer is indebted to Messrs. Flaherty and Morgan, of Port Arthur, and to the several prospectors met in the Savant region. Mr. F. M. Handy acted as field assistant during this season and performed the greater portion of the topographic work.

History of the Iron Range

Although Prof. W. G. Miller[1] as early as the year 1903 mentions the occurrence of magnetite on the shore and islands of lake Savant, and also the probability that a typical iron range would be found farther west, it was not until about the year 1906 that the main range was staked. In the latter year Mr. W. H. Collins made a reconnaissance trip through the lake Savant region and wrote a brief account of the iron formation.[2]

Some development work in the form of shaft sinking, test-pitting and stripping has been performed, but no diamond drilling has been done, nor has any attempt at mining been made, as "pay ore" has not been located.

During last summer five men were employed in doing assessment work on the claims along the south side of lake Kashaweogama, where the main range reaches its greatest width, and several prospectors were locating claims on other portions of the range. At that time no staking had been done on the range just south of Iron lake, where it is wider than in many other places which have been staked. Some claims have been staked between Grebe and Pickerel lakes on an insignificant outcrop of iron formation, and others on small outcrops near Cliff lake.

The building of the Transcontinental railway will have a great influence in opening up this and surrounding areas, by permitting more satisfactory work upon the range already staked and increasing the chances of making further discoveries.

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[1] W. G. Miller, 12th Rep. Bur. Min., 1903, p. 313. [2] W. H. Collins, Summary Rep. Can. Geol. Surv. 1906, p. 103.

Geography

Position and Extent of the Area

The area included in the accompanying map lies in unsurveyed territory. It is situated in latitude between parallels 50 deg. 30 min. and 50 deg. 15 min., and in longitude between meridians 90 deg. 25 min. and 91 deg. 25 min. It is about 45 miles in maximum length by 12 miles in maximum width, and lies with its long axis nearly east and west. Extending along the central portion of the area there is a chain of lakes beginning with lake Savant on the east and ending with lake Kimmewin on the west, which lakes, with the connecting streams form an excellent canoe route.

The iron range area may be approached by various routes, and a description of these may prove of value to travellers. The easiest and most desirable route to follow is that by way of Superior Junction, the point where the Lake Superior Branch of the G T.P. railway meets the main line of the Transcontinental. This village is situated on the

Fig. 1. Scene on Sturgeon river above Superior junction.

Sturgeon river, about 11 miles below Dog Lake portage. The river is large, the current almost negligible, and the portage to Dog lake is short, as, indeed, are all the portages on the route. Dog river, above the lake of the same name, is a good stream for navigation by canoe, as the current is not at all troublesome. There are between Superior Junction and lake Kashaweogama only nine portages, the longest, that into Dog lake, being less than half a mile, while the others are less than ten chains in length.

There is, at the time of writing, railway connection with Sturgeon lake, from which two routes lead to Kashaweogama. One runs from Trapper's Cabin at the northern limit of North Bay, a point reached by steamer, and the other leaves Northeast Bay at a point also reached by steamers. When the Transcontinental railway is complete the route from Trapper's Cabin will be greatly improved, as the first portage of about 3½ miles now in existence will be almost eliminated. At the time our excursion was made it was possible to have goods transported by waggon from Trapper's Cabin, 3½ miles, to lake Chivelston. From the latter lake a portage about five-eighths of a mile long leads to Harris lake, from which a portage of three-eighths of a mile leads to another lake to the north. From the latter lake the best route is one with good portages leading through lakes Handy, Pickerel and Grebe to Kashaweogama. Another route runs from the above-

mentioned lake by a portage three-quarters of a mile long to lake Savant, whence two routes to Kashaweogama may be followed, one by way of Grebe and the other by way of Iron lake.

Rocks Between Westfort and Superior Junction

As one leaves Westfort on the new G.T.P. railway he observes very little rock, except glacial drift, on which are located a number of farms, until Duna is reached, about twenty miles from Westfort. At this point there occurs an interesting green schist, apparently of Keewatin age, and containing a large number of quartz veins, chiefly as small stringers. None of these, however, appear to be mineralized. This type of rock continues to near the station called Griff, where Laurentian granite and gneiss appear and extend a long distance northwest, just how far was not determined, as darkness prevented observa-

Fig 2. Falls at outlet of Island Lake.

tions. The Height of Land is crossed near Dexter, about 50 miles from Westfort, and the Laurentian area is characterized by immense swamps and muskegs lying between low hills of drifts or knolls of granite and gneiss. In this area occurs a portion of the bog iron district described in the last report of the Bureau of Mines.

Around Superior Junction Keewatin rocks are exposed, and just behind the railway station there is a mass of volcanic agglomerate resembling conglomerate in some respects, but differing from it in that the majority of the fragments are angular and unassorted, and further, in that the fragments consist almost exclusively of rhyolite.

From Superior Junction to Dog lake the rock on the southeast side of the Sturgeon river consists almost entirely of quartz-porphyry, while green schist and some tufaceous rocks occur along the opposite bank. There are no glacial lake beaches in this area.

Soil and Forests

The soil of the area explored is similar to that which is found over the greater portion of the rocky districts of northern Ontario. There is probably less distinctly sandy soil than in many other areas, because of the absence of the sandy, shallow water deposits of the great glacial lakes which covered large areas in the Nipigon and other regions.

The forests are similar to those so often described in other northern districts, and consist chiefly of spruce, balsam, tamarac, poplar, cedar, jack-pine and birch. There are some areas of jack-pine and spruce which will be valuable as timber lands, but on the whole the timber is small and short. A few red and white pine were seen. A number of red pine trees occur on the Sturgeon river above Superior Junction, and a few red ones and a white one as far north as the north bay of Island lake (Fig. 3). The fires have

Fig. 3. Red and white pine on Island in the North Bay of Island Lake

not yet devastated as much of this area as of so many farther east and south, and it is only in a few places, such as on the small lakes above lake Kimmewin, on Island lake, and on part of lake Kashaweogama, that much of the timber has been destroyed.

Fish and Game

The only fish taken by our party were pike, pickerel and suckers. A number of the lakes contain an abundance of pickerel (Fig. 4), and lake trout are said to be abundant in lake Savant. There are many beavers, otters and bears; and game in the form of partridges, rabbits, moose and caribou is plentiful. Seven moose were seen during the first two weeks spent in the field.

Surveys

No survey lines have been run in the area mapped except the trial lines of the G.T.P. railway, which were later abandoned. These lines have been placed on the map, and they have proved very serviceable in forming a base to which the micrometer and compass surveys made last summer could be attached.

In gathering the data for the accompanying map a track survey was made of the lower part of Cliff lake, of Pickerel, Handy and other small lakes, and a micrometer and dial compass survey of lakes Iron and Kashaweogama, while much of the other topographic data was obtained directly from W. H. Collins' map, already mentioned[3] although in many cases minor changes have been made in it.

Topography

There is a certain uniformity about the topography of this area, as there is about many other portions of the peneplain covering northern Ontario. The greater part lies

Fig. 4. One hour's catch of pickerel with troll in Island Lake.

at an altitude of about 1,300 feet, and few of the hills rise more than one hundred or even fifty feet above the general level of the region, though rarely, as west of Iron lake, they may be as much as 200 feet in height.

The immense number of lakes with intricate outlines is a striking feature. The strike and nature of the containing rock have a great influence on the form of the lakes. In schist they usually occur as long narrow bodies lying parallel to the strike of the schist, with here and there constricted portions cutting across the strike of the schist nearly at right angles. Lake Kashaweogama and Island lake lie mostly in schist or conglomerate, and follow the strike of the rocks pretty closely. The long bay on the south of Island

[3] Can. Geol. Surv., 1906, map No. [illegible], compiled by W. H. Collins.

lake and the southern extension of Iron lake bear in their form and their relation to the surrounding rocks somewhat the appearance of having served as pre-glacial river channels. Cliff, Grebe and Curlew are good examples of lakes contained by granite or gneiss shores, and with their numerous irregular bays exhibit a much more intricate outline than do the lakes in the schist, as the long axes of these bays lie in all directions. These numerous lakes, some of which are of large size, furnish the area with first-class facilities for travel by canoe. Lake Savant is about 23 miles in its greatest dimension, and Cliff lake, though not much explored, is about 15 miles. The latter lake probably gets its name from the numerous steep cliffs along its shores. Lake Savant is characterized by numerous islands and many large bays, most of which are comparatively shallow. It has the character of a lake formed by the damming of a pre-glacial water course by glacial drift.

Many large swamps occur, such as those west of the southern end of Cliff lake and north and south of Island lake and lake Kashaweogama. The swamps, which lie on ground moraine, occasionally extend over two miles and break the continuity of the rock formations. In most cases there are scattered over them numerous drumlin-like knolls of drift, and in places the ground moraine grades into eskres and limited terminal moraine. One of these terminal moraines, about 85 feet in height, completely buries from view the iron range just south of the eastern end of lake Kashaweogama

Geology

Historical Geology

The following classification may be applied to the rocks of the lake Savant area:

Pleistocene: Drift.

Pre-Cambrian:
- Keweenawan: Diabase.
- Lower Huronian: Conglomerate, a little arkose and greywacké, and probably a few small patches of quartzite.
- Laurentian: Granite and gneiss.
- Keewatin: Banded Iron formation, greywacké and fine-grained grey gneiss, rhyolites, quartz-porphyries, tuffs, greenstones and green schists.

When the rocks are compared with those of other Keewatin areas with which the writer is familiar farther east in Canada, there are a few striking differences. The most noticeable are the great amount of greywacké occurring in the Keewatin, and the presence of considerable amounts of a fine-grained, grey, biotite gneiss, which appears to correspond closely with the gneisses described as Couchiching by Lawson. It would appear that this type of gneiss is probably more widely distributed in the regions lying in the vicinity of Lake of the Woods than in the regions farther east. In the field it is hard to classify much of the gneiss as a meta-igneous or meta-sedimentary rock, but a study of thin sections shows that the specimens which could not always be separated in the field may have been obtained from an altered igneous rock in one case, and an altered sediment in another. The igneous rocks giving rise to the gneisses are usually rhyolites or quartz-porphyries, and the sediment has the appearance of having been derived by the alteration of similar rocks. The greywackés have a composition such as to suggest that their origin was from rather basic rocks, and it seems probable that these gneisses may have been developed by the disintegration and partial decomposition of the more acid rocks which form a considerable portion of the complex Keewatin series.

In places these sediments appear to grade gradually over into distinct igneous rocks in the form of quartz-porphyries and rhyolites, and altogether the great quantity of partially decomposed material in the form of greywackés and gneisses suggests the possibility of much sub-aerial rock decay in Keewatin time. That both the greywacké and the above-mentioned gneiss are older than the conglomerate, which shows every evidence of being the basal conglomerate of the Lower Huronian, seems to be affirmed by the numerous pebbles of both of these rocks in the conglomerate, by the inter-banding of

these rocks with the Iron formation, fragments of which are also included in the conglomerate, and by the intrusion of both of these rocks by the Laurentian granite. The presence of so much greywacké with the Iron formation and the absence of Iron formation pebbles in large areas of the conglomerate, at first led the writer to regard the Iron formation as of Huronian age, and he believes that Mr. W. H. Collins has entertained the same view as a result of his field work in the region,[4] but the finding later of large numbers of Iron formation fragments in the conglomerate, as well as other considerations, seemed to establish definitely the greater age of the Iron formation and greywacké.

The typical extrusive Keewatin greenstone is almost lacking except in the eastern portion of the area, where a considerable portion of the south end of lake Savant is bounded by it. The Laurentian system is well developed in this area, the greater portion being covered with granite and gneiss. There seems to be a possibility that all the granite mapped as Laurentian may not be of that age, but that some of it is of an unknown age, younger than Laurentian. The evidence for regarding some of the granite

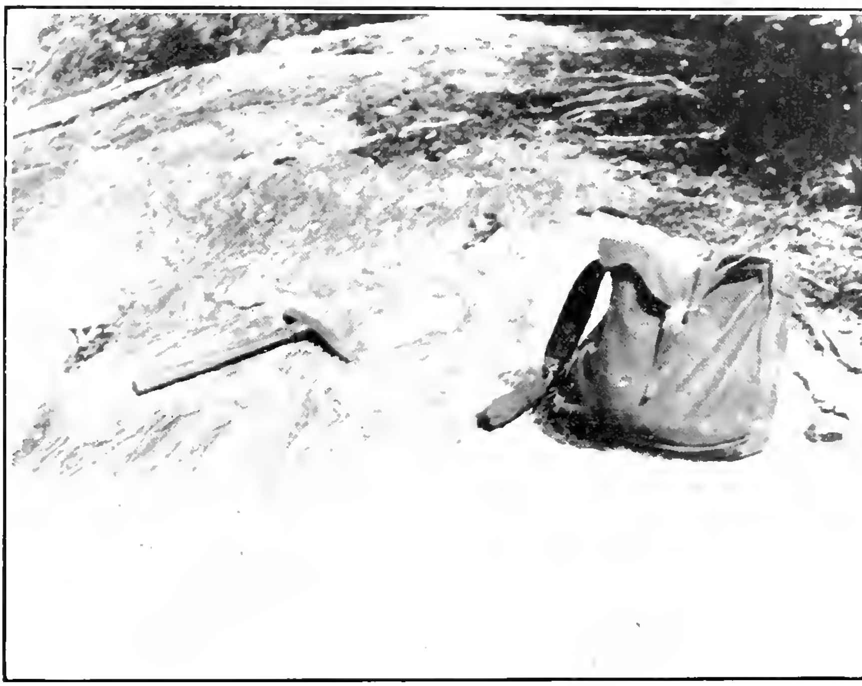

Fig. 5. Lower Huronian conglomerate on Dog river.

as younger is found in the much less metamorphosed condition of considerable areas, the overlying of distinctly gneissic masses by comparatively little metamorphosed masses, and the cutting of portions of the gneiss by dikes. The first of these factors cannot be regarded as proof of the younger age, and the dikes were only seen in one place on Cliff lake. The frequent occurrences of dikes, of the nature of pegmatites, in the Laurentian granite of many districts, makes the evidence of the last two factors unreliable as definite evidence. It would, however, be interesting, should further and more detailed work ever be carried on in the vicinity of Cliff lake, to endeavor to establish the ages of two series of granites in that area.

[4] Report on a Portion of Northwestern Ontario Traversed by the National Transcontinental Railway between Lake Nipigon and Sturgeon Lake, by W. H. Collins, Canadian Department of Mines, Ottawa, 1908.

There are in parts of the area, chiefly around Island lake, numerous quartz veins which in places are mineralized, but we did not succeed in panning gold from any of them. One of the veins near the outlet of Island lake is about five feet in width, and can be traced for about 100 feet before it passes under the lake. From the fact that the quartz veins are closely connected with the contact between the Laurentian and Keewatin, and as far as observed are not found in the Huronian, their age would appear to be about that of the Laurentian granite. Observations in the Sturgeon lake region to the south, where similar veins occur, have also led the writer to regard them as being about Laurentian in age.

The Huronian conglomerate occurs here in an unusually long and continuous band over 30 miles in length. It is made up chiefly of large and well-rounded granite pebbles, which often, though not always, show extensive water action. Many of the pebbles have been drawn out into lenses by excessive metamorphic processes. (Fig. 5.)

The conglomerate in places grades over into an arkose and greywacké, and it is often difficult, unless this relation can be traced out, to distinguish between some of the areas of Keewatin and Huronian graywacké. A few small patches of impure quartzite south of lake Kashaweogama are probably of Huronian age. The relations between the conglomerate and Laurentian granite are interesting, and will be described in the section on the Huronian conglomerate.

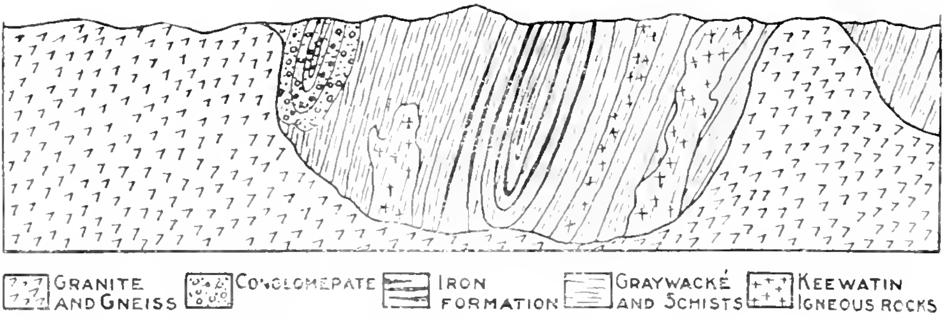

Fig. 6. Diagram representing the structural relations of the Keewatin, Laurentian and Huronian rocks.

It seems reasonable to regard as Keweenawan in age certain diabase dikes which occur in this area and are similar to the Keweenawan diabase in other regions.

There is nothing striking or unusual about the drift in the area.

Structural Geology

The structure of the lake Savant area, like that of most pre-Cambrian areas, is very complex. A glance at the map accompanying the report suggests that the long conglomerate band extending northeast near the northern border of the Keewatin rocks, and the band southeast of the narrows on lake Savant, striking so as to apparently converge with the former band, formed the limbs of an anticlinic pitching to the northeast. Although such a structure was kept in mind in the field, it was found impossible to establish any definite arrangement, and it was concluded that the form of the Keewatin areas is largely that assumed under the influence of the post-Keewatin folding accompanied by the intrusion of the granite, and that the conglomerate bands represent the remains of irregular synclines developed in the Keewatin, or along the contact between the Laurentian and Keewatin, when the post-Lower Huronian folding occurred. (Fig. 6.) The minor foldings in the Keewatin are very complicated, and it is probable that the same complications would be found in the larger folds if they were worked out. On Cliff lake it was at first found difficult to follow the strike of the schists, as one would

frequently pass from rocks with a north and south to those with an east and west strike. But later it developed that the structure was similar to that represented in diagram (Fig. 7), and the minor folds are an index to the structure of the major.

The Keewatin Rocks

The Greenstones and Green Schists.—As the stratigraphy table previously given shows, the Keewatin system is supposed to consist of greenstones, green schists, rhyolites, quartz-porphyries, tuffs, greywacké, fine-grained, grey gneiss and banded iron formation.

The typical basaltic greenstones do not constitute nearly so large a proportion of the Keewatin system as they do in most other Keewatin iron range areas. In studying the region from west to east one is struck by the absence of the typical greenstone until he reaches lake Kashaweogama, where a small body of ellipsoidal greenstone occurs on the north shore, about one-fourth of the length of the lake from the west end. Little of this rock is then seen until lake Savant is reached, where a large area of it occurs on the southeast shore above the narrows. (Fig. 8.)

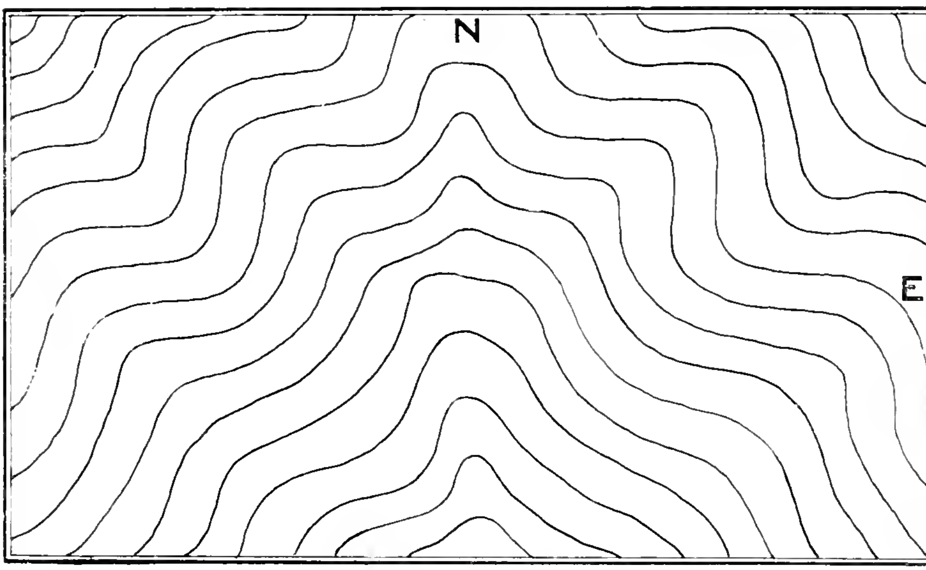

Fig. 7. Diagram illustrating in horizontal plan the folding of the greywacké and schists on the southern portion of Cliff Lake.

Although these are the most important outcrops of the typical extrusive basic rocks of the Keewatin, there are many outcrops of rocks, such as dark hornblende-porphyries, diorites and other rocks of average composition, so altered as not to be easily determined in the field, and it seems certain that many of the green schists have been developed from all of these igneous rocks. On the north shore of lake Kashaweogama, east and west of where the G.T.P. location line crosses the lake, there are considerable areas of diorite, but this rock seems to be fresher and on the whole younger looking than most of the Keewatin greenstones. Such was found to be the case with the diorites in other Keewatin areas,[5] and Mr. Collins makes the same observation for diorites in the Sturgeon lake area.[6] Some of the diorites contain quartz; and in most cases the feldspars are greatly altered, and the hornblende largely bleached and fibrous. For want of more definite evidence they have been classed with the other Keewatin greenstones.

[5] Iron Range north of Round Lake, 18th Rep. Bur. Min., 1909, p. 157.
[6] Report on a Portion of Northwestern Ontario Traversed by the National Transcontinental Railway, p. 16, Can. Geol. Surv., 1908.

The hornblende-porphyries were found in several places with the Iron formation in extremely complicated relations. These occurrences were noted chiefly in the Iron formation just south of lake Kashaweogama. When these rocks have been highly metamorphosed a hornblende schist is a characteristic result. The porphyries usually occur as a fine-grained, greyish-white rock, with dark spots of hornblende. In thin section the ground mass is found to be composed of feldspar and small crystals of hornblende, the former somewhat saussuritized and showing considerable zoisite. In one case a number of deep blue hornblende crystals were seen as phenocrysts. Iron pyrite is common, and is usually partially altered to limonite.

The Rhyolites and Quartz-Porphyries.—The rhyolites and quartz-porphyries are rather widespread, the most prominent areas lying around lake Houghton and along the lakes south of lake Savant. They are often highly metamorphosed and hard to distinguish from the grey, fine-grained gneiss, some of which has been developed by the

Fig. 8. Greenstone hills on the shore of Lake Savant.

metamorphism of these rocks. The quartz-porphyries are light grey or pinkish in color, and often contain distinct phenocrysts of quartz. One striking feature is the blue opalescent color of the phenocrysts near the contact between these and the Laurentian granite. In thin section there is nothing unusual about the color of the quartz, but in the hand specimen this feature was so striking that one could often recognize the proximity of the contact by the presence of the blue quartz crystals. Beyond this there is nothing peculiar about the rhyolites and quartz-porphyries, unless it be the unusually coarse nature of this rock along the railway try-line a short distance west of lake Kashaweogama, where the quartz phenocrysts are as much as a quarter-inch in diameter. They seem to represent the acid phase of the Keewatin eruptions, intrusive and extrusive. Near the southern portion of lake Houghton, as Mr. Collins mentions, there is a crushed quartz-porphyry, north of which the rock has been so weathered and rearranged as to resemble a grit of some sort.

The Fine-Grained Grey Gneisses (Couchiching?).—Grading into the main porphyry area, closely associated with the masses of quartz-porphyry and rhyolite described above, there are large masses of fine-grained, light grey gneiss, often granular and sugary in appearance, which the writer regards as equivalent to the Couchiching described by Lawson in the Lake of the Woods region. The relation of the gneiss to the acid eruptives of the Keewatin in this area has led to the conclusion that a portion of the gneiss has been developed by the dynamo-regional-metamorphism of the acid eruptives, and the remainder by the disintegration and partial decomposition, by weathering, of these rocks. The resemblance of this gneiss to the Laurentian gneiss is so strong that an inexperienced person readily confuses them, and yet there is, to one accustomed to both types, a characteristic difference. The Laurentian is, on the whole, coarser, darker in color, and not so granular and sugary in texture. The prospectors and others in the area readily

Fig. 9. Camp on an island in Lake Kashaweogama. A pot hole may be seen in the schist just to the right of the bow of the canoe.

mistook large areas of this gneiss for the Laurentian. That it is older than the Huronian conglomerate and also than the Laurentian is shown by the abundant pebbles of the rock in the conglomerate, and the numerous places where it is cut by the granite. It is closely associated between Pickerel and Grebe lakes with Iron formation, the latter occurring as narrow bands in a sedimentary type of this rock.

The distribution of the gneiss is quite extensive as it occurs as a band, in places as much as two miles wide, extending from Schist lake across the long southern bay of Island lake, lake Houghton, Pickerel lake to lake Savant. It also occurs along the north central portion of lake Kashaweogama.

A specimen of this rock collected on Schist lake is bright grey in color, and finely banded, with thin streaks of biotite running through it. Under the microscope the section consists of a very fine-grained quartz matrix with streaks of larger grains of quartz, and greenish-brown, strongly pleochroic biotite running across

the section at rather regular intervals. The plates of biotite are very small. Little particles of magnetite occur rather widely distributed, but also segregated along the lines of the biotite bands. Two small grains of bluish tourmaline were seen, the source of which is probably the Laurentian granite. The presence of biotite is a characteristic feature.

Sericite Schists.—Along the north shore of lake Kashaweogama, just east of the point where the railway line crosses the lake, there are a number of bands of sericite schist consisting almost entirely of quartz and sericite. The bands of schist vary in width from 2 feet to 20 feet, and they are distributed along the shore of the lake for a couple of miles. The rock is cut up by greenstones in such a manner as to suggest that the sericite schist has been formed by the contact metamorphism of quartz-porphyry intruded by greenstone.

Quartz Veins and Gold Placers.—Mention has already been made of the numerous quartz veins occurring in the lake Savant area. These veins begin to attract attention in the Keewatin in the western portion of the tract, but become very prominent on

Fig. 10. Pot hole in schist on shore of island in Lake Kashaweogama. The water has enlarged a hole begun by the ice.

Island lake. They vary in width from mere stringers to ten feet, and consist either of pure white quartz or of white quartz highly charged with pyrite and muscovite. No free gold was found in these veins, though a few pannings were made, and a diligent search was instituted in a number of the veins. Prospectors have also found them barren, as so far as observed none of the veins had been staked, though they had been tested by shots in a number of places. As the veins resemble those which appear to be connected with the Laurentian intrusion in the Sturgeon lake region farther south, and as fragments of similar vein quartz were often found in the Huronian conglomerate, it seems probable that they are about Laurentian in age.

There have been reports of gold placer discoveries on the lower portions of lake Savant, and Prof. Miller in 1903 describes some placers on the islands and the shore of the lake in the vicinity of the narrows.[7] The gold occurs in the sand, which here forms a large portion of the glacial drift, and Prof. Miller considers that its source was the quartz veins in the surrounding Keewatin rocks. When the writer visited the area a very short time was spent in this vicinity, and although a few pannings of the sand from several placers were made, he was not successful in obtaining colors of gold. This cannot be taken as evidence that no gold is present, since, as Prof. Miller states, the gold is rarely found by panning, but an analysis by fire assay often reveals its presence when panning does not. His analyses show the gold values varying from a trace to $2.00 a ton of 2,000 pounds.

Fig. 11. Greywacké on shore of Iron Lake.

Greywacké.—Greywacké is a widely-distributed rock in the lake Savant area. It is especially abundant along the west shore of the lake, where it extends from below the narrows northward to beyond the portage from Iron lake. It is often very schistose, and in places where fine-grained grades into a slate. (See Fig. 10.) In the vicinity of the conglomerate it passes into that rock; but a distinction must be made between the Keewatin and Huronian greywackés. The Keewatin greywacké forms the country rock

[7]12th Rep. Bur. Min., 1903, pp. 88-90.

for the greater portion of the Iron formation, and along the west shore of lake Savant is interbanded with narrow seams of iron oxide. These seams may vary in width from a half-inch to a hundred yards of impure Iron formation.

The greywacké containing the bands of iron is regarded as Keewatin in age, because pebbles of this rock occur in the Huronian conglomerate and are also cut by the Laurentian granite.

The greywackés are monotonous rocks of a dark grey color, often weathering to light grey. In thin section they are found to be composed chiefly of angular fragments of quartz and feldspar lying in a finer matrix of the same materials. The feldspars are often largely the lime-soda type, but also frequently predominantly orthoclase. Iron carbonate, limonite, pyrite and magnetite, especially the first, are characteristic minerals. A little hornblende often occurs, and chlorite is plentiful. The composition of the rock suggests its derivation chiefly from basic igneous rocks, as the feldspar is the type occurring in the latter, and what might appear to be an excess of quartz for such derivation may be partially accounted for in the supply of free silica furnished by the decomposition of silicates. The decomposition and rearrangement of minerals in all these old rocks have been extensive. The general absence of much evidence of water action seems to point towards much sub-aerial rock decay.

The Iron Formation.—The Iron formation has a wide distribution. Beginning on the west shore of lake Savant, it extends more or less continuously westward for about 25 miles, reaching beyond the southern end of Cliff lake. Narrow bands of magnetite and jasper occur in the greywacké all along the west shore of lake Savant from the narrows to beyond the portage from Iron lake. Few of these bands are large enough to merit attention. There is a small outcrop on the east shore of the lake just south of lake Savant. South of the eastern portion of lake Kashaweogama the range becomes more concentrated, and the most important portion of it occurs in this vicinity. The range is here about one mile wide, with a band about a quarter-mile wide fairly free from country rock. South of the main band there are a number of parallel narrow bands of no economic interest. The main band narrows where it comes out on the shore of Kashaweogama, and the range is only represented by small outcrops on a few islands, until near the western part of the lake, where a small outcrop occurs in a large hill on the north shore, only to disappear in a large swamp and reappear again around the south end of Cliff lake.

Part of the western portion of the range is composed almost entirely of banded quartz and actinolite. The rock is quite similar to the regular Iron formation, but the percentage of iron is so small that it has all been employed in the development of actinolite, leaving no excess of iron oxide. Associated with the actinolite are crystals of grünerite, the brown amphibole, and in one section a couple of crystals of augite were recognized by the extinction angle of about 50 deg. These bands in the western portion are narrow and of little economic importance.

Composition of the Iron Formation.—The Iron formation consists of banded red jasper, and magnetite and quartz in the form of interlocking crystals developed by the crystallization of chert. The bands in the jasper vary in width from microscopic size to a quarter-inch or even an inch in width. This banded jasper is again interbanded with wide and narrow bands of greywacké, hornblende schist and a grey, fine-grained gneiss. By far the most common rock occurring with the red jasper and magnetite is greywacké, and the bands of jasper and greywacké vary greatly. In places there is as much as 50 feet of almost pure red jasper and magnetite, while in others these minerals occur as bands only an inch or two wide in large masses of schist or greywacké.

The greater portion of the range contains a large percentage of magnetite, apparently the result of excessive metamorphism. Where the range is in proximity to the granite, as it is in many places, the iron is largely in the form of magnetite. Where the iron is not in excess of the magnesium and silica necessary to make actinolite, an actinolite schist with little magnetite is the result. The percentage of metallic iron in the Iron

formation is, on the whole, rather low. Two analyses of samples taken from the main range south of lake Kashaweogama and analysed by Mr. N. L. Turner, Provincial Assayer, gave the following results:

		Per cent.
Specimen No. 265	Metallic Iron	33.36
	Silica	50.20
Specimen No. 271	Metallic Iron	43.82
	Silica	39.00

One of the prospectors, Mr. M. Kane, who is interested in some of the claims, kindly furnished the writer with a table of three analyses made for him by Mr. W. W. Benner, analytical chemist, Port Arthur. The results are as follows:

		Per cent.
Sample No. 1	Metallic Iron	42.41
	Silica	37.86
Sample No. 2	Metallic Iron	70.07
	Silica	2.30
Sample No. 3	Metallic Iron	51.53
	Silica	21.04

Fig. 12. Shaft on iron range on South Shore of Lake Kashaweogama.

These figures are obtained from the analysis of picked samples, and while they cannot be taken as representative of the iron content of much of the Iron formation, they indicate that there are spots in the range where concentration has taken place. There has been a good deal of test-pitting and stripping, and one or two shafts have been sunk 15 or 20 feet (Fig. 12), but no drilling has been done, and so far nothing which can be regarded as "pay ore" has been located. The greater portion of the Iron formation, even where free from schist, does not carry more than from 30 to 35 per cent. of iron.

There are, however, certain features about this range which appear to the writer to make it a little more promising than many other low-grade Keewatin ranges found in

northern Ontario. The jasper and magnetite lie in a vast quantity of sedimentary rock, and as this rock is closely folded there are indications that the Iron formation extends to great depth, as the synclines do not appear to be so shallow as in many areas where igneous rocks break up the continuity of the strata. The range is in this respect a little more like the Huronian than the Keewatin ranges. In the greater depth there seems to be a factor favoring concentration at considerable distance below the surface. There is also evidence in many places of the leaching of silica and iron, leaving the Iron formation in a porous condition, as may sometimes be seen in the vicinity of ore bodies. The range is rather narrow compared with the ore-producing ranges with which the writer is familiar, and this feature is unfavorable to the occurrence of large bodies of ore, though in the widest portion its dimensions cannot be regarded as prohibitive of ore bodies of moderate extent. The only portion which is of any economic interest is the widest part south of lake Kashaweogama.

Fig. 13. Crumpled Iron formation, south of Lake Kashaweogama.

Genesis of the Iron Formation.—In a previous article may be found the writer's opinions regarding the genesis of some of the Keewatin Iron formations.[8] Since writing that article he has visited the Vermilion Range of Minnesota, and after seeing the great areas of jasper interbanded and in close contact with basaltic flows, can more fully appreciate the force of Dr. Leith's argument favoring these flows as the source of the solutions, which, poured out into the sea, deposited the jaspers. It was also noted that the acid eruptives and jaspers have to a large extent similar relations to those of the basalts and jaspers. In the Onaman Iron Range, described in the article just mentioned, the acid rocks seemed to occupy a much closer relation to the jaspers than did the greenstones, and there are several ranges in which these acid eruptives have similar relations. If they could be regarded as a probable source of the iron-bearing solutions, that might account for these relations and favor the igneous origin of the rocks in some cases where it is difficult to refer their source to the basic flows. The writer does not, however,

[8] 18th Rep. Bur. Min., 1909, pp. 239-243.

regard them as the source of the ores, though they are a probable source of much silica. In the Savant lake area almost the only igneous rocks in close relation to the iron deposits are the hornblende-porphyries, which may be regarded in most cases as intrusive rocks. Whence, then, the source of the iron? There are no doubt plenty of igneous rocks in the region to supply the ore, but their relations to the jaspers do not seem to indicate them as the source. Instead of the igneous rocks being interbanded with the Iron formation, the latter is made up of large quantities of greywacké evidently derived from the partial decomposition of the igneous rocks. If the igneous rocks supplied the iron solutions to the seas there should be greater regularity in the distribution of the Iron formation, a smaller proportion of imperfectly water-worn sediments, and a closer relation between the igneous rock and the jasper.

For the Savant region it appears that conditions favor deposition in bodies of water of limited size and surrounded by land areas capable of furnishing the materials for the greywackés. The source of the iron must have been chiefly the igneous rocks which were

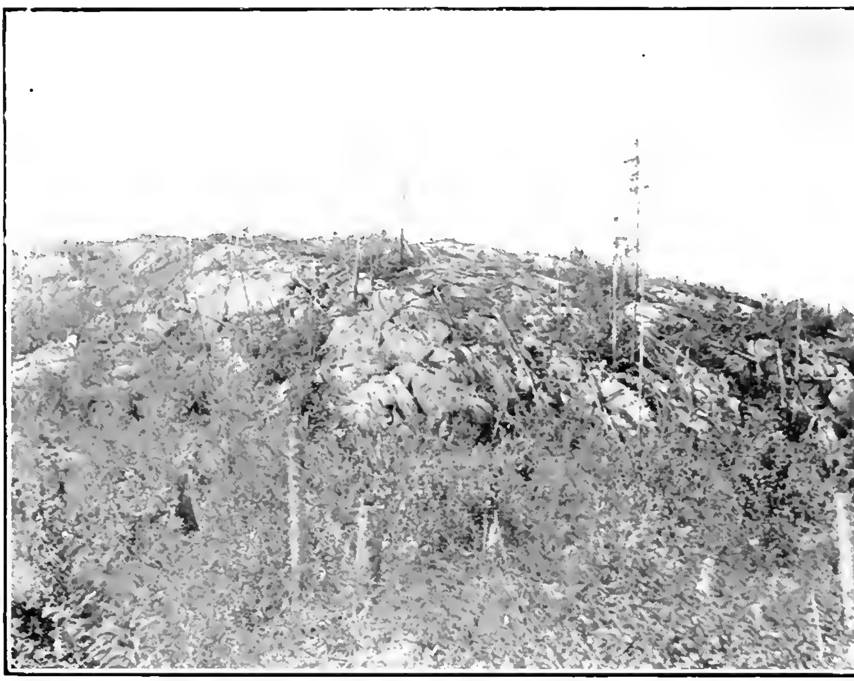

Fig. 14. Laurentian granite hill, near Dog river.

decomposed, supplemented to some extent by solutions supplied directly to the bodies of water by heated igneous rock. The Iron formation must have reached its present condition through extensive metamorphic processes by which rearrangement of the iron and silica took place, emphasizing the banded formation and changing the chert from a crypto-crystalline mineral to a granular crystallized mass. In this range, as in other Keewatin ranges, the earliest iron compound, the remains of which may still be recognized, seems to have been the carbonate, which is now very largely altered to magnetite by excessive metamorphism, while the quartz seems to have originally been in the form of chert. There are grains of pyrite scattered through parts of the narrow greywacké bands occurring with the jasper, but these do not appear to have any particular bearing upon the origin of the main iron deposits.

Laurentian Granite and Gneiss

The Laurentian granite and gneiss practically encircle the area under discussion, though in a few places the Keewatin throws out huge arms of green, which lie across the flesh-colored area in various directions. The rock is mostly a biotite gneiss or granite, but there is also a great deal of hornblende granite. Some of the granite looks much fresher and less metamorphosed than does the greater portion, and it is possible that there are in this area granites of two periods of eruption, though no definite evidence of this has been obtained.

Fig. 15. Huronian conglomerate on the shore of Lake Kashawogama.

The Laurentian has supplied a great quantity of the material for the Huronian conglomerate, and the relations between these two rocks are very striking and will be considered when discussing the conglomerate.

The Huronian Rocks

The presence of large bands of conglomerate in the Savant area has been mentioned by Collins and McInnes, and the writer found, besides several minor outcrops, a band extending almost continuously from a point on a small lake below Schist lake through to lake Savant. The band is broken in Island lake, but otherwise it is represented by outcrops, large or small, for almost the entire distance. This rock seems to have had an important bearing on the formation of the main waterway, as the Dog river and several

of the large lakes lie along the band. There are also minor outcrops on lake Savant just southeast of the narrows; on the southeast shore of Pickerel lake there is a very small body, and south of Fisher lake a limited mass was seen. The latter outcrops were too small to be placed on the map, but they doubtless represent the outliers of a much more extensive body of conglomerate, the remains of which are now only to be found in synclines.

These bands of conglomerate are regarded as of Lower Huronian age because they lie upon the Keewatin and Laurentian, contain pebbles of practically all the rocks of those two systems, and are of the general characters of the Lower Huronian conglomerate in other regions. The most prominent pebbles are granite and gneiss, which vary in size from a half-inch to 20 inches in diameter. In some places the rock is crowded with these pebbles, while in other places they are sparsely distributed. Many are well rounded, but in other cases they are rather angular, and by reason of dynamo-metamorphism the larger proportion of them are drawn out into lenses or thin bands. (Fig. 15 represents very well an outcrop of this rock on the southwest shore of Lake Kashaweogama.)

A glance at the accompanying map shows that for a long distance the conglomerate band is in contact with the granite. This contact is rather puzzling in places, and Collins considers that the granite on Schist lake is in igneous contact with the conglomerate.[9] Although recognizing the similarity of this contact to an igneous type, the writer is of the opinion that the contact is rather due to a decomposition of the granite in place, just as the Keweenawan red shales can sometimes be seen passing by gradual transition from distinct shales in one place to solid granite in another, and yet the result resembles a metamorphic change due to contact action In no case were granite dikes found cutting the conglomerate so as to show definite evidence of igneous contact.

On the shore of lake Savant numerous Iron formation pebbles occur in the conglomerate, and almost everywhere the rhyolite, quartz-porphyry, hornblende-porphyry, fine-grained grey gneiss and green schist pebbles may be found, though these are as a rule smaller and not so well preserved as the granite pebbles, which seem to have withstood the processes of metamorphism better.

No definite evidence of glacial origin for this conglomerate was observed, though what might be regarded as soled boulders were found in one or two cases. The pebbles on the whole seem to have suffered too much water action to have preserved any glacial striae, if they had ever possessed them. The thickness of the conglomerate is rather difficult to determine, as the rock has been so closely folded, but Mr. Collins appears reasonable in his estimate that it does not exceed 100 feet in most places. The dip is about 70 deg. on an average, and northward. The strike varies, but in many places runs about 60 deg.

The matrix of the conglomerate is a dark grey or green schistose material, in composition similar to a greywacké or arkose. In places it grades into a greywacké with very few pebbles, and from this to a distinct greywacké. At times the pebbles are so scarce that it is very hard to recognize the rock as conglomerate. Unless the transition is followed out in the field, it is difficult to distinguish between the Keewatin and Huronian greywackés.

One or two small outcrops of quartzite were seen in the region, but no bodies of such dimensions as mentioned by one writer[10] were seen. Even these masses might be regarded as nearer arkose in composition than quartzite. A few small bodies of arkose were observed, and it is probable that these arkoses and quartzites should be regarded as Huronian in age.

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[9] A Geological Reconnaissance of the Region Traversed by the Nat. Trans. Ry. between Lake Nipigon and Clay Lake, Ont. Rep. Can. Geol. Surv., 1909, p. 34.

[10] McInnes, Summary Rep. Can. Geol. Surv., 1901, pp. 92-93.

Keweenawan (?) Diabase

There are in several places in the area dikes of diabase which resemble those of Keweenawan age in the Nipigon region, and it is probable that they belong to that system, though there is no data to fix their age limit. They are the youngest consolidated rocks occurring in the area. Two of the dikes may be seen cutting the Laurentian gneiss on the portage leading north from Island lake towards Cliff lake.

Pleistocene Deposits

The fine glacial lake terraces of the Nipigon region are lacking in the Savant area. Though the drift is heavy in places, and completely buries the Iron formation from view, there are abundant rock exposures. The ground moraine forms large, low areas covered with swamp, and scattered over these are low knolls of drift, somewhat drumlin-like in form, and with their longer axes running in a general direction a little east of north. A terminal moraine lies along the south side of lake Kashaweogama near the eastern end, and prohibits access to the Iron formation in that vicinity.

Fig. 16. Features produced by weathering in a conglomerate containing very few pebbles, Lake Kashaweogama.

The direction of a few glacial striae was noted, and found to be about 30 deg. magnetic. The abrasive action of the glacier has been considerable, but apparently not so extensive as in other areas of greater topographic relief.

Summary

The Lake Savant Iron Range area is about 45 miles in maximum length and 12 miles in maximum width. It extends westward from the southern portion of lake Savant, and crosses the boundary between the districts of Thunder Bay and Rainy River.

The rocks of the area belong to the Keewatin, Laurentian, Huronian, Pleistocene and possibly the Keweenawan systems. The Keewatin system is composed of a complex of acid, intermediate and basic eruptives, intrusive and extrusive, and with these there is an unusually large percentage of sediments iu the form of greywacké and fine-grained, grey gneiss. The Iron formation is of Keewatin age, and consists of red jasper and banded silica and magnetite. These minerals are interbanded with large amounts of greywacké. The banded Iron formation does not contain a high percentage of iron, and no "pay ore" has so far been struck, but the range is nearly 25 miles long, about one mile wide in the widest place, and it is probable that the syncline in which the Iron formation occurs reaches a great depth, as there is a thick mass of sediments associated with the range, and these are closely folded.

The Huronian system consists chiefly of conglomerate grading into greywacké, and in a few places to arkose. There are some small bodies of impure quartzite. The conglomerate is represented by an unusually continuous band extending across the greater portion of the area.

The Keweenawan system may be represented by a few dikes of diabase

The drift of the Pleistocene is heavy over much of the area, but there is nothing of striking interest in its occurrence.

NEPHELINE SYENITES OF PORT COLDWELL

BY H L KERR

Historical

The earliest mention which has been found of these rocks is in the Report of the Geological Survey of Canada for the year 1846-47. The same account occurs in the 1863 volume. In the latter report, on pages 80 and 81, it is stated that Pic island and Old Pic Point appear to be composed chiefly of a coarse-grained granitoid rock, consisting essentially of brownish feldspar and black hornblende. The report also mentions the occurrence of nepheline in these words: "Judging from the fragments on the shore, there are some beds composed of white feldspar, with occasional groups of orange red grains of eleolite, the whole studded with brilliant black crystals of hornblende, forming a very beautiful rock." In the same volume, on page 480, in the chapter on mineral species, the following sentence occurs: "Grains of orange red nepheline or eleolite are abundant with black hornblende in a white feldspathic rock, which is found in boulders on Pic island, in lake Superior." Again, on page 647, it is suggested that this nepheline rock may be miascite. The presence of zircons in the dark syenite is also noted in this place, which leads the writer to suggest a resemblance to the zircon syenites of Norway.

In the Geological Survey Report of 1871-74, Dr. Robert Bell speaks of the rock at the mouth of the Little Pic river as being granitoid gneiss.

Port Coldwell Harbor.

No further mention of these most interesting eruptives is found in any of the literature for the next quarter of a century. Then in 1898 Prof. A. P. Coleman, of the University of Toronto, while doing some work in the neighborhood of Heron Bay, discovered a new rock species, consisting largely of analcite, to which he gave the name "heronite." After giving a full mineralogical and chemical description of the rock, he says: "One naturally expects to find the dike containing the rock described in connection with some boss of nepheline syenite, but the slight examination hitherto made of the region by Dr. Bell and myself, has not disclosed any area of that rock."[1] Heron Bay, as a matter of fact, is less than ten miles from the eastern limit of the eruptive series, consisting largely of nepheline syenites, described in this paper.

[1]Journal of Geology, Vol. VII., No. 5, p. 435; also Rep. Bur. Min., 1899, pp. 172-174.

In this same connection Dr. Frank D. Adams describes microscopically two rock specimens from Peninsula Harbor, found in the museum collection at Ottawa. He notes the remarkable resemblance of these rocks to certain Norwegian species, and strongly supports Prof. Coleman's suggestion that nepheline-bearing eruptives must occur in the near neighborhood.[2]

During the summer of 1900 Prof. Coleman again visited the Heron Bay district, for the purpose of tracing the connection between the heronite dike and possible nepheline-bearing rock areas. While not successful in this, he was nevertheless fortunate in discovering certain other dikes containing nepheline, and thus obtaining more conclusive evidence of the presence of those rocks in that neighborhood.[3]

In 1901 another attempt was made by Dr. Coleman to locate the nepheline-bearing area. In his report to the Bureau of Mines for that year he says: "In connection with an excursion to the iron ranges of the Slate islands, an opportunity was taken to examine the railway and shore near Port Coldwell, and it was intended to visit Pic island, a few miles off shore, where Prof. Pirsson and others have suggested that nepheline rocks would probably be found, but unfortunately no suitable boat could be got at the little harbor, and this had to be given up."[4]

However, a trip was made along the Canadian Pacific railway track from Heron Bay to Middleton, and an extensive group of syenites was located, extending from three miles east of Peninsula as far west as Middleton. Among these were found a considerable extent of nepheline-bearing rocks and closely associated species, which Dr. Coleman briefly described in the Eleventh Report of the Bureau of Mines.

In this report he also notes the striking resemblance which these eruptives bear to those so elaborately described by Brögger from the Christiania region.

During the following summer Prof. T. L. Walker, of the University of Toronto, spent a few days collecting museum specimens along the C.P.R. in the same region. It was at his suggestion that the writer began the study of the specimens collected by himself and Dr. Coleman, with the idea of spending some time during the following summer in mapping the area in detail.

In the fall of 1906, six weeks were spent in the Coldwell district gathering information regarding the extent of these syenites. The weather was not very favorable for working, but a good section was obtained along the C.P.R. track, and a limited examination further north was made. Part of the coast was explored, and a couple of days were spent on Big Pic island. The work was left in such shape, however, that rather full information could be readily obtained during the next visit to the region. Compass lines were run north in two or three places, on which stakes were planted every six chains, so that these points might be connected up with future work.

During the fall of the next year another visit was made to the district with a couple of men, and the intention was to remain until satisfactory information regarding the whole area had been obtained. The weather conditions were more unfortunate than during the previous year, for it rained about three days out of four during the month spent there, and the weather not giving any evidence of changing for the better, the work was left in an uncompleted condition. We were more fortunate this year, however, in the matter of obtaining a boat, so that it was possible to spend a couple of days more on Big Pic island, besides getting an almost complete section along the coast, and visiting all the islands in the neighborhood. Little Pic river was also explored and some definite information obtained here, although even on that short trip heavy rains interfered with the work.

[2]Journal of Geology, Vol. VIII, p. 322. [3]9th Rep. Bur. Min., 1900, pp. 186-191.
[4]11th Rep. Bur. Min., 1902, p. 208.

Although the information regarding the area is far from complete, yet the rocks collected include probably all the varieties occurring there, and it has been decided to publish the information collected, with the hope that at some future time it may be made more complete.

Distribution of Nepheline Rocks in Canada

Until a short time ago, nepheline rocks were considered of very rare occurrence. This was probably due to the fact that few men were able to recognize nepheline in the field. As far as Canada is concerned, these rocks can no longer be looked upon as curiosities, and it is very likely that as our great northland becomes more intimately known, other areas of these interesting eruptives will be located.

Although the Port Coldwell syenites are the earliest mentioned of all the nepheline-bearing rocks in the Dominion, it is but recently that they have attracted the attention of the petrographer, while several other areas have been described in the meantime in more or less detail.

Probably the most famous are the corundum nepheline syenites of east central Ontario. Several reports and papers have been written on this region by Professors Willet G. Miller, Frank D. Adams, and Dr. A. E. Barlow,[5] while a more exhaustive report for the Canadian Geological Survey is in the press at the present time.

Another important area which has been described by Adams and others, is found in the neighborhood of Montreal, embracing what are known as the Monteregion Hills, of which Mount Royal is the most famous.[6]

Dr. Willet G. Miller, who was the first to describe the central Ontario area in any detail, has discovered three other occurrences which are worthy of note. In 1891 he located an area about twenty miles east of the Ottawa river in the neighborhood of Hull, Quebec. He described them as being similar in character to the rocks of eastern Ontario, and believes a belt of considerable extent exists in this part of Quebec. In the same paper in which he refers to the Hull occurrence, he mentions an area discovered by himself 140 miles northwest of that place near Kippewa river, about 20 miles northeast of the south end of Lake Temiskaming. The rock exposure here, which is described as being 400 yards wide, shows well-developed schistose character and considerable variety of mineralogical composition. Like the area in eastern Ontario, it is associated with crystalline limestone.[7]

Dr. Miller has also described boulders of nepheline rock which he found near Sturgeon lake, 150 miles north-west of Port Arthur. He believes that an area of the rock *in situ* is to be found in this locality, basing his opinion not only on the presence of the many boulders of nepheline rock, but also on the field relations of certain other eruptives.[8]

Lawson has described a peculiar nepheline-bearing rock from Poohbah lake, Rainy river district, Province of Ontario. These nepheline pyroxene malignites, as Dr. Lawson has named the nepheline-bearing members of the group, are distinct from any other of the nepheline rocks of Canada, as far as is known.[9]

In British Columbia Dr. Barlow has briefly described certain nepheline sodalite syenites from the Ice river country.[10]

[5] Am. Journal of Sci., Vol. XLVIII., July, 1894, pp. 10-18. 8th Rep. Ont. Bur. Min., 1899, pp. 205-240. Also see same Report, pp. 250-253 (on Corundiferous Nepheline Syenite), by Dr. A. P. Coleman. Geol. Surv. of Canada, 1892 and 1893, part J, p. 5. Transactions of the Royal Society of Canada, Third Series, 1908-1909, Vol. II., Sec. iv.

[6] Geol. Surv. of Can., Vol. XIV., Sec. O. Geol. Surv. of Can., Vol XVI., Sec. H., Geology and Petrography of Mount Yamaski, by G. A. Young. Geol. Surv. of Can., Vol. XVI., Sec. G., Geology of Brome Mountain, Que., by John A. Dresser.

[7] Am. Geol., Vol. XXIV., p. 276. [8] Am. Geol., Vol. XXIV., p. 276.

[9] University of California, Bulletin of Dept. of Geology, Vol. I., p. 337.

[10] See Transactions Royal Society of Canada, Vol. IV., p. 81. Also see Geol. Surv. of Canada, Vol. I., p. 116B. Also Geol. Surv. of Canada, Vol. III, p. 111R.

Port Coldwell District in General

The Port Coldwell district, by which is meant that part of the north shore of lake Superior occupied by the eruptive rocks discussed in this paper, is situated about 125 miles, by way of the main line of the C.P.R., east of the city of Port Arthur. The section of country represented on the map accompanying this report, begins a few miles west of where the railway track first touches Lake Superior. Although the district is only about fifteen miles from east to west, the railroad which passes through it is over 21 miles long.

The whole country consists largely of high-rolling hills, with a very light covering of soil, the rocks in general being exposed and readily accessible for examination. The highest hills of the district are those consisting of the nepheline syenites. In the neighborhood of Red Sucker, and in the Coldwell Peninsula, they reach an elevation of 250 to over 700 feet above the lake, but the highest hill of the whole district is that found on Pic island, also nepheline syenite, which is about 850 feet (aneroid) above the lake. Both to the east and the west of this central part of the area, the hills are lower, and more rolling.

Forest fires have destroyed most of the timber along the railroad track itself, and the result is that most of the country for a mile back on both sides is covered with fallen trees, which makes travelling difficult. In the unburnt country exploration would

Looking west from near Peninsula.

be comparatively easy. The timber is all small, and consists chiefly of black spruce and balsam, averaging less than 10 inches in diameter, with stretches of white birch of a larger size, and here and there occasional fairly large white spruce. The timber would be very difficult to get out, excepting in the neighborhood of the Little Pic river, and it is doubtful if even there lumbering could be carried on advantageously.

Two or three excellent harbors exist along the coast, the principal one being Peninsula Harbor, which is doubtless sufficiently deep to accommodate any vessels sailing on the lake. It is well protected by the point known as Peninsula, as well as Lighthouse island. The lighthouse situated at the southern point of Lighthouse island is one of the landmarks along the coast. It is kept lighted from the beginning to the close of navigation, and serves as a guide for the vessels passing along the south on their way to the western ports. The harbor at Coldwell is also well protected. It is not nearly so large, but serves as an excellent haven for the fishing schooners of the district.

Port Coldwell itself is the chief settlement. Besides the station, which is over 100 feet above the level of the lake, a small collection of fishermen's houses is situated at the foot of the bay. At Middleton, the station master and his family and the section men are the only inhabitants. At all the other points in the district, the only inhabitants are section men and watchmen, and the total population, including the lighthouse keeper and his family, is probably less than fifty.

The only industry of the region is fishing, Port Coldwell being an important point along this part of lake Superior. Three or four outfits of fishermen ply their trade here during the open season, and several tons of fish are shipped weekly from the district to Montreal, Toronto, and eastern cities of the United States.

Extent and Relation of the Port Coldwell Syenites

These eruptions occupy the district from three miles east of Peninsula Harbor as far west as the C.P.R. station of Middleton, on the north shore of Lake Superior. They were found as far north as our exploration extended, excepting on the Little Pic river, where they are replaced by granites a mile or so from the lake. The coast line from Middleton to Peninsula is entirely taken up by them, and they also form all the islands in the neighborhood, including both the Little Pic and Big Pic. They therefore occupy a known area of approximately 100 square miles.

Chlorite schists and greenstones of Keewatin age are associated with the syenites along the lake shore in the east and the west. These Keewatin rocks have a northward extent of from four to twelve miles. In the east they are replaced by Laurentian gneisses and schists about twelve miles from the lake, as observed on the Big Pic river. In the neighborhood of Middleton, the Keewatin was found five miles to the north, as

Peninsula Harbor.

indicated on the accompanying map. Beyond this exists an immense area of Laurentian rocks consisting of schists, quartz-porphyries, granite gneisses, granites, syenites, etc.[11]

The syenites of the Coldwell massif are younger than the Keewatin, as shown by the numerous dikes of the former penetrating the latter. Beyond this, very little can be said regarding the relative age of the syenites in this petrological province to the surrounding rocks.

Directly north of the syenite area it is very probable that the country is occupied by Laurentian gneisses, schists, and granites similar to those found on the Little Pic in the west, and the Big Pic in the east. From information obtained from people living in the country, and from personal observation, it seems probable that the syenites extend to the north less than ten miles from the lake.

Where the granites of the west come in on the Little Pic river, no relationships were observed, and possibly the syenites merge without any sharp line of demarcation into the granites.

[11] See Geol. Surv. of Can., 1903-1905; Reports by W. J. Wilson and W. H. Collins.

The Nepheline Syenites

Owing to the variety of texture and mineralogical composition, it is rather difficult to give a single description that would apply to all the nepheline syenites. They may, however, be said to be holocrystalline, medium-grained granitic rocks, varying in color from pale to dark grey. In many cases they possess a distinct pink to purplish tint, owing to the presence in most cases of hydronephelite spreustein, which is a decomposition product of the nepheline. Frequently they possess a trachytic structure, due to the peculiar development of the feldspars. This is especially well illustrated in certain parts of the country north of Mile Post 78. In the most typical nepheline syenites, the dark constituents form a small percentage of the rock, but frequently these ferro-magnesium minerals are more important, and at times the hornblende in particular is developed into long, lath-shaped crystals with a more or less parallel arrangement, giving the rock a most characteristic appearance.

The hydronephelite spreustein, besides being present in various sized aggregations, from the size of a pin head to pieces half an inch or more in cross section, is finely disseminated throughout the rock. When in any considerable quantity, it gives the rock a very striking appearance, and frequently serves when less abundant to identify it as one of the nepheline series.

Looking west from Peninsula Harbor.

Occasionally the rock possesses a more or less gneissoid structure, but this is not at all common. A peculiar banded appearance was noted in a small area of the nepheline syenite on the west side of Coldwell peninsula. In this place the rock is made up of coarse-grained bands of light grey color, six inches to a foot wide, mottled with patches of sprenstein, and carrying comparatively little of the dark minerals, alternating with much narrower bands of a darker color, and made up largely of hornblende. Occasional much smaller bands consisting almost entirely of hornblende occur.

The weathered surface, owing to the rapidity with which the nepheline decomposes, frequently shows the characteristic pitted appearance seen in the field in other localities.

Mineral Composition of Nepheline Syenites

The chief constitnent, feldspar, is always readily recognized in hand specimens. Frequently the feldspar is present in rather well formed crystals, giving the rock a semi-porphyritic appearance, but this condition is not nearly so prevalent as in other associated rock types, and it seems to he confined in the nepheline-bearing members to

those rather poor in this constituent. Where well-developed feldspar crystals occur, they frequently possess a more or less parallel arrangement.

Nepheline with its characteristic oily lustre is readily discerned with the naked eye. In many cases it makes up as much as one-sixth of the rock. Again, it may be present in subordinate quantities, and only recognized with difficulty in hand specimens.

Hydronephelite spreustein or ranite is always present, and serves as a valuable index in the field.

Both hornblende and magnetite and the less abundant pyroxene are also easily distinguished. In most of the more typical varieties they are present in subordinate quantities, while in others they form a large percentage of the whole, sometimes indeed forming the bulk of the rock.

Face of nepheline syenite hill, just west of Port Coldwell station.

Feldspar

The most variable of all the minerals of these nepheline syenites are the feldspars. In few of the specimens studied has it been possible to find undoubted orthoclase in any quantity, nor on the other hand do any of the distinct nepheline syenites show plagioclase as the chief feldspathic constituent. All the feldspars belong to the natronorthoclase microperthite series. All gradations from the undoubted pure natronorthoclase to distinct microperthitic intergrowths of orthoclase and albite are found.

In the more distinctly nepheline predominating varieties, the sections of feldspar are more or less homogeneous in appearance, and it is only with difficulty, and by the use of the higher power of the microscope, that any albite lamellae may be found. The other varieties of the rock poor in nepheline show distinct albite twinning in most of the feldspar crystals, but with an irregularity of form and arrangement that is characteristic. Other sections show a decided difference in the intensity of polorization tints, which suggests lack of homogenity in chemical composition. This difference is

confirmed by testing the refractive index of the two parts by Beck's method. Then as the nepheline content of the rock becomes insignificant, the chief feldspar is microperthite, with the albite arranged generally in definite orientation, probably parallel to the steep othodom (801) as shown by Brögger, in the Norwegian occurrences.[12]

The feldspars usually occur in xenomorphically bounded crystal fragments, but at times well developed crystals occur, and as stated above, occasionally a semi-porphyritic appearance results. These subhedral crystals are quadratic to lath-shaped, parallel to the c axis. In the better formed crystals Carlsbad twins are quite common. Both where the plagioclase has a readily recognizable definite orientation, and where such definite arrangement is most difficult to determine, the plagioclase itself is characterized by the extreme irregularity of its individual parts. The microperthitic bands which cross the crystal parallel to the orthodiagonal are irregular in shape and of varying width; in individual bands they may wedge out in the centre of the section, or break up into several smaller bands, or one band may cross over the intervening space, and unite with another band. The same is true of the occasional fragments

Microperthite from the nepheline-poor syenite.

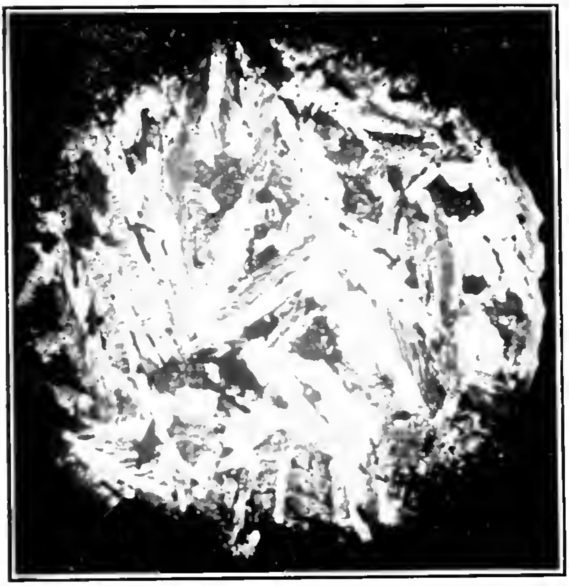
of albite, seen in the natronorthoclase. They possess no definite or constant form, but may appear in irregular patches, or lath-shaped particles running part way through the section and wedging out.

Under the low power many crystals appear absolutely homogeneous with uniform extinction in sections parallel to (010) of about 12° against the trace of (001). When examined by the higher powers, albite lamellae of extreme delicacy may be frequently observed in the section. Sometimes this twinning is only recognizable with the nicols in the 45° position. In cases where the feldspar is microperthitic in character, the albite part of it is almost invariably the fresher of the two. Even where no twinning lamellae can be seen, parts show a distinctly higher index of refraction owing to the higher soda content. Many sections display the characteristic moire structure common in the natronorthoclase from other localities.

[12] Zeitschrift f. Cryst. u Min. band 16, 1890, pp. 524-551.

Besides this undoubted primary differentiation of the feldspar crystals, occasionally crystals are seen with an outer, clearer, fresh border, which upon closer examination is seen to be small crystal fragments of albite, which are undoubtedly of secondary origin, resulting from the breaking down of the original crystal.

The writer was fortunate in having access to numerous slides of the nepheline syenites from different parts of the world, which are in the University collection, being thus enabled to make comparisons with them. The rocks, the feldspars of which most closely resemble the Coldwell varieties, are those described by Brögger of Norway. Many of the specimens collected in the Port Coldwell area have exact duplicates among the Norwegian types. This resemblance is particularly well marked in many of the feldspars themselves. The descriptions and cuts given by Brögger[13] are duplicated on every hand among these feldspars, and, as will be seen below, the chemical analysis also corresponds very closely.



Microperthite from rock poor in nepheline.

The chief inclusions found in the feldspar are small crystallites of hornblende, angite, magnetite and biotite, with some very fine delicate crystals of apatite.

In many of the rocks poor in nepheline hypidiomorphically developed feldspars have a more or less parallel arrangement, simulating flow structure. Particularly good examples of this are found among the rocks along the line explored north of Mile Post 78.

Nepheline

Nepheline is always the last constituent to crystallize. Almost invariably it is made up of irregular pieces filling in the spaces among the other minerals. It is usually partly decomposed, and not infrequently has been almost completely replaced by resulting decomposition products. Even here, however, it is usual to find a small fragment in the centre of the mass which is readily recognized as nepheline. Generally speaking, the nepheline is easily distinguished by its characteristic dark blue polorization color and definite arrangement of inclusions, or in the less fresh examples by the decomposition products. Where any doubt as to its identity was felt, microchemical tests were employed. It is much more abundant in some rocks than others. For instance, the rock in the big hill just east of Coldwell is probably made up of a sixth or more of nepheline; the same may be said of the rock on the west side of Coldwell peninsula, and

[13] See Zeitschrift für Krystal, u. Min. Band 16, 1890.

part of that on the south side of Pic island. Some show a very small percentage of this constituent, and it might be almost looked upon as an accessory mineral. This is true of most of the nepheline syenites on the north side of Pic island, as well as some found north of the C.P.R. tracks in the neighborhood of Mile Post 78.

Inclusions in the fresher specimens are made up chiefly of hornblende, and some augite with other small undetermined crystals. These inclusions are arranged chiefly parallel to the axial directions, being much more numerous in the direction of the c axis. Occasionally larger crystals of the feldspar are included in the nepheline mass.

Besides the hydronephelite spreustein described below, scales of muscovite are commonly present as decomposition products in certain localities.

Parallel arrangement of microperthite.

Hydronephelite Spreustein

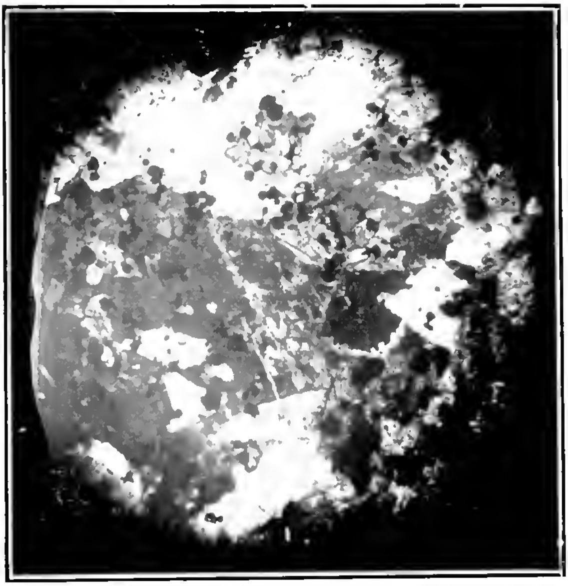
The most striking constituent in any of the nepheline syenites is the orange red decomposition product of the nepheline. As stated above, it occurs in nearly all of these rocks in crystal aggregates from the size of a hazel nut to fragments of microscopic dimensions. When present in any considerable quantity in the larger-sized aggregates it produces a most beautiful rock, which might be profitably used for ornamental purposes. It is undoubtedly the material referred to by Logan as orange colored nepheline.[14] In many places throughout the region small dikes, filling the contraction cracks which cut the main body of the rock in all directions, are made up largely of this substance. It was from one of these dikes in the west of Coldwell peninsula that the material for the analyses given below was obtained. This decomposition product corresponds most closely to the ranite or hydronephelite spreustein of the Norwegian rocks.

That it is a decomposition product of the nepheline is conclusively proven by the various stages of transition noted from different parts of the region. In a specimen of rather fine-grained rock obtained a mile and a quarter north of Mile Post 78, on the C.P.R., small specks of this mineral are numerous, and these under the microscope are seen to have the original form of nepheline crystals, with a small fragment in the centre of fresh nepheline.

[14]Geol. Surv. of Can., 1863 p. 480.

The idiomorphic rectangular form of these crystals is a rather unusual condition in the nepheline of this area, for, as already stated, it is usually found in irregular pieces filling in the spaces among the other constituents. From many other parts of the field various stages in the transition from the nepheline to the aggregate were observed.

Under the microscope this hydronephelite spreustein is seen to be made up of innumerable irregularly arranged masses of fibrous crystals, sometimes with a radial arrangement. Even in thin sections the characteristic red color is nearly always seen. However, the individual crystals are so extremely delicate in all the sections examined that even under the highest power it was found impossible to identify the different minerals.



Nepheline syenite.

Among the Norwegian rocks in the University collection are some from the Yttre Aro, Langesund Fjord, containing spreustein, which have an identical appearance in hand specimens with the Coldwell variety. A thin section of this particular rock was made, but even under the microscope no marked difference to the lake Superior variety could be detected. The chemical composition, however, places it with the ranite or hydronephelite rather than with the true spreustein. The following analyses are associated for purposes of comparison.

—	I.	II.	III.	IV.	V.
SiO_2	38.72	38.86	38.99	39.21	42.80
Al_2O_3	33.76	33.82	33.62	31.79	28.50
Fe_2O_3	Trace	Trace	....	0.57	0.34
CaO	6.31	6.36	0.07	5.07	1.90
MgO	0.19	0.14	....	....	....
Na_2O	9.56	9.38	13.07	11.55	14.33
K_2O	0.16	0.08	1.12	....	0.30
H_2O	12.02	11.94	12.98	11.71	10.81
Total	100.72	100.58	99.85	99.90	98.98
Spec. Grav.	2.34	2.34	2.263	2.48	2.275

I. and II. Material obtained from small dike on west side of Coldwell Peninsula, by Mr. Rothwell, Fellow of Chemistry in School of Practical Science, Toronto.
III. Hydronephelite from Litchfield, Me., U.S.A.
IV. Ranite from the Island of Loven, Langesund Fjord, Norway.
V. Hydronephelite from Ice River, B.C.

Sodalite

One of the surprises of the nepheline syenites of the Coldwell area is the almost entire absence of the mineral sodalite. This mineral is a common constituent of the rock in many other localities, but here it is chiefly conspicuous by its absence. Although found in the rock in widely separated localities, yet that it is not a common constituent is shown by the fact of its absence from 75 per cent. of the sections studied. Where present, it occurs as irregular grains filling in among the other constituents, in the same way as the nepheline, but it is readily recognized by its constant isotropic properties. Although thin sections of nepheline cut perpendicular to the optic axis never give a well-marked interference figure, yet they usually give a distinct cross, while the sodalite, being isotropic, shows no such cross.

A more or less gneiss-like nepheline syenite which occurs two miles north of Mile Post 78 in the high ridge along the line explored here, has a fairly large percentage of

Zonal texture in the hornblende of the nepheline syenite from western part of Coldwell peninsula.

sodalite. The same is true of a specimen obtained from the top of the highest hill southwest of Coldwell station, inland from the west side of Coldwell harbor. The farthest projection of Pic island towards the southeast is also made up largely of a medium-grained, light-colored rock, different in appearance from almost every rock in the district, and carrying considerable quantities both of nepheline and sodalite. Outside of these three localities sodalite was rarely seen, and then always merely as an accessory mineral.

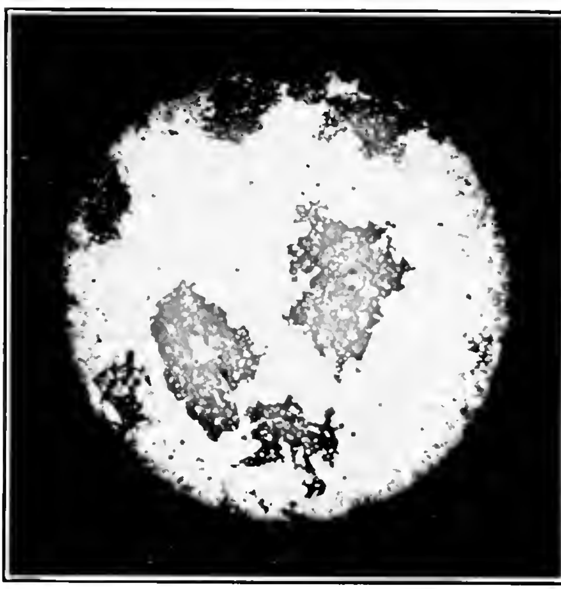
Hornblende

By far the most abundant and prevalent ferro-magnesium constituent of these nepheline rocks is hornblende. Usually the mineral has very imperfect crystal outlines. Frequently only xenomorphically bounded crystal fragments occur, and it is seldom found in well-developed anhedral forms. Occasionally there is a remarkable development of the crystal parallel to the c axis giving rise to crystals many times longer than wide. Some measured were found to be two to three inches long, and only a small fraction of an inch in width. There may be more or less parallel arrangement of the crystals in such cases, or a radial arrangement about a common centre. This excep-

tional development of the hornblende is, however, restricted in the nepheline-bearing types to small patches in the main body, and to certain small dike-like developments filling in contraction cracks.

Pyroxene is usually present even in the types where hornblende greatly predominates. Where these two minerals occur together, kernels of augite with a surrounding border of hornblende are abundant. In none of the sections examined was one observed in which hornblende formed the central part of an augite crystal. Sometimes this central part has well-developed crystal outlines, but usually is an irregularly bounded fragment. The relative size of the two bisilicates varies from that in which the augite makes up the major part of the crystal, to that in which it sinks to microscopic proportions.

In hand specimens the hornblende presents a brilliant black appearance on the cleavage surfaces. In thin sections it varies from green to chestnut-brown in color. Very frequently the interior of the crystals is much lighter in color than the outer



Poikilitic texture in hornblende in nepheline syenite. Augite kernel in centre of one hornblende crystal.

border. In the brown varieties there is a distinct difference in shade of color between the two parts, while in the green type a pale green interior with a deep green border is found. In many cases the crystals have a spotted appearance, due to the different coloring; or again, are uniform in color throughout.

Pleochroism is very marked, and varies from different shades of brown and green to black. The most frequently observed colors were:

Parallel $\mathfrak{b}$ chestnut brown.
Parallel $\mathfrak{a}$ greenish yellow.
Parallel $\mathfrak{c}$ dark brown.
with absorption : $\mathfrak{b} > \mathfrak{c} > \mathfrak{a}$

In the green varieties the predominating colors were:

Parallel $\mathfrak{b}$ green.
Parallel $\mathfrak{a}$ straw yellow.
Parallel $\mathfrak{c}$ grass green.
with absorption : $\mathfrak{b} > \mathfrak{c} > \mathfrak{a}$

The crystals possess positive elongation, and are optically negative. Extinction angles are much larger than in most hornblende, 25° having been observed, although commonly they are less than this.

Twins are frequent, particularly in the brown varieties. Twinning plane and composition face is the front pinacoid (100). Occasionally polysynthetic twins are seen.

Prismatic cleavage is usually well developed. In many cases there is a well-marked parting at right angles to the prismatic cleavage.

It is probable from the above considerations that the mineral is barkevikite, although no chemical examination in proof of this supposition has been made.

In several places hornblende is poikilitically intergrown with the feldspar. This structure is particularly well developed in the rocks two miles north of Mile Post 78, and also along the north shore of Pic island. Magnetite as an inclusion is always present, and apatite in large, clear crystals is quite common.

Pyroxene

After hornblende, the chief dark colored constituent of the nepheline-bearing rocks is pyroxene. It varies from a deep green aegerine augite to a slightly colored diopside. Generally speaking, the pyroxene is present in hypidiomorphic to xenomorphic crystals. Only occasionally do well-formed crystals appear. The chief faces are (110), (010), (100), (001) and probably (101). The deep green aegerine augite is confined to the rock in which nepheline is most abundant. It will be described first.

The grass-green color of this pyroxene is one of the most striking features of any of the minerals present. In some specimens the color is practically uniform throughout the crystal, but, generally speaking, there is a distinct difference between the shade of green in the interior of the crystal and that along the outer rim. Where there is a difference, the outer rim is always the more deeply colored part, and it usually shows a distinctly smaller angle of extinction and more marked pleochroism.

The sections usually show an elongation parallel to the c axis, and, while the regular prismatic cleavage is, as a rule, well developed, yet in some cases it is practically absent.

Pleochroism is very strong in many cases, and shows the following relations in the more deeply colored varieties:

Parallel $\mathfrak{a}$ grass green.
Parallel $\mathfrak{b}$ yellowish green.
Parallel $\mathfrak{c}$ yellow.
with absorption: $\mathfrak{a} > \mathfrak{b} > \mathfrak{c}$

Where there is a difference between the interior and the outside of the crystal, the outer rim shows deeper shades of the same colors, with corresponding absorption.

Undoubtedly the chemical composition of this pyroxene varies in different rocks. This difference is shown by the variability in the intensity of color. Extinction angles also vary for the same reason. What appears to be the most characteristic aegerine-augite shows an extinction from 39° to 40°. This extinction is, as pointed out by Brögger for certain of the Norwegian pyroxenes of the same type, the direction of the greatest elasticity, while in diopside it is the direction of the least elasticity. As mentioned above, where the composition of the crystal varies, the extinction of the outer more deeply colored rim is always noticeably smaller.

The mineral is optically positive.

While pyroxene is usually present in the rocks of this group, it is commonly subordinate in quantity to the amphibole, and is frequently closely associated with it. Very often the pyroxene forms an inner kernel surrounded by a border of amphibole. In relative proportions these minerals vary from the case in which the pyroxene sinks to microscopic proportions in the centre of the crystal, to that in which the hornblende is present only as a rim on the outside. This illustrates again most strikingly the extreme variability in the mineral composition of these rocks.

In many of the nepheline syenites, diopside takes the place of the aegerine-augite. It is usually seen in irregular grains and subhedra, of a pale green color, occasionally showing a faint pleochroism in tints of green. Where crystal forms are at all developed the chief faces are (110), (100) and (010). Frequently a border of deeper green of an aegerine character has been found along the outer rim of the crystal. Here, as in the other variety of pyroxene, it often forms the kernel in the centre of a hornblende crystal. The characteristic prismatic cleavage is usually better shown than in the more sodaliferons type. Inclusions are chiefly grains of magnetite, and rather large crystals of clear apatite.

Biotite

Although biotite is by no means a common constituent of these nepheline syenites, nevertheless it is found in many places in small irregular fragments associated with the other dark constituents, and occasionally, as for instance in certain places in the southwest part of Coldwell peninsula, it is the chief dark colored mineral of the rock. It is the common brown to green biotite, and possesses no unusual features worthy of notice. In the beautiful pink nepheline syenite which occurs as a dike at Mile Post 79 on the C.P.R., a deep green biotite, which is the only dark silicate present, is invariably associated with grains of magnetite, about which it is arranged in small scale like crystals as an outer border. These small dark specks unite with the little pink spots of hydronephelite-sprenstein in giving this particular rock a striking appearance, seen in no other place in the field.

Muscovite

Besides being a frequent decomposition product of the nepheline as noted above, muscovite was found in a few cases as an original constituent. This is true of certain varieties of the rock seen in the west part of the Coldwell peninsula about midway between Pic channel and the C.P.R. tracks, along the most westerly line explored. It occurs as small aggregates of irregular scale-like crystals, readily detected by the high polorization colors and characteristic cleavage.

Sphene

Reddish brown crystals of sphene were found in sections of the rock from certain localities, but it is not by any means a prominent constituent. Occasionally it occurs in rather well-developed crystals, but generally is present in irregular anhedra. It is most frequently seen in rocks containing biotite, and in certain sections of a typical miascite from the southern part of west line through the Coldwell peninsula it occurs as a border around grains of magnetite. It is slightly pleochroic in different shades of brown.

Magnetite

Besides occurring as inclusions in the other dark constituents, or forming centres about which biotite or sphene is developed, as noted above, magnetite is found also in scattered grains throughout the feldspar in many of the sections examined. Well-developed crystals are not common.

Grains of pyrite are seen very sparingly throughout the rock in the same association as the magnetite.

Fluorite is of rare occurrence, but is seen occasionally as purplish grains, which are perfectly isotropic.

Analyses of Nepheline Syenites

Chemical analysis of the two types found at Coldwell indicates that whereas the rock of the big hill by the small lake east of the station is a typical nepheline syenite of the foyaite variety, the rock nearer the station itself, and forming the high hill northeast of the little fishing village, has more the composition of a gabbro or essexite. The third analysis, given below, is of a nepheline syenite of a trachytic type, which unfortunately was slightly decomposed. The latter rock is from a mile and a half north of Mile Post 78, and represents a variety prevalent in that locality.

The last two analyses are associated with the analyses given of the Coldwell rock for purposes of comparison.

——	I.	II.	III.	IV.	V.
SiO_2	55.59	55.11	60.92	59.70	51.90
Al_2O_3	23.55	16.76	21.34	18.85	22.54
TiO_2	....	0.78	....	....	....
P_2O_5	....	0.49	....	....	....
FeO	3.28	5.72	3.44	....	3.15
Fe_2O_3	....	2.18	....	4.85	4.03
MnO	0.45	0.28	....	....	....
CaO	1.87	6.66	1.34	1.34	3.11
MgO	0.78	3.20	0.16	0.68	1.97
Na_2O	8.05	3.98	6.02	6.29	8.18
K_2O	5.04	3.25	6.33	5.97	4.72
H_2O	1.21	1.66	0.60	1.88	0.22
Total	99.82	100.07	100.15	99.56	99.82

I. Analysis of typical nepheline syenite, from just east of Coldwell station, by E. L. C. Forster, M.A., Fellow in Chemistry, School of Practical Science, Toronto University.
II. Analysis of nepheline-bearing rock, just west of Coldwell station, by F. A. Genth, of Germantown, Pa.
III. Analysis of nepheline syenite, from north of Mile Post 78, by E. S. Moore, B.A.
IV. Analysis of eleolite syenite (grey granite), by W. A. Noyes, Arkansas Geological Survey, Annual Report, 1890, Vol. II., page 88.
V. Analysis of laurdalite, Lunde, by G. Forsberg. Zeit. F. Kryst, u. Min., 1890, Band XVI., page 41.

Transition Stages in the Syenites

One of the most remarkable features of these syenites is the rapidity with which they change from coarse-grained varieties, where the dark constituents are subordinate, to finer textured, darker colored types where the dark amphiboles and pyroxenes stand out prominently, often with well-developed, long, lath-shaped crystals. Then, too, there is no distinct contact between the nepheline syenites and the other syenites with which they are associated, but a gradual transition from one to the other. This is also true of the changes from one type of nepheline syenite to another type. The latter feature is well illustrated in the neighborhood of Port Coldwell station. Here we can trace the gradual change from the pinkish grey nepheline syenite forming the high hill by the little lake east of the station to the dark grey type resembling diorite in the first cut west of the station platform, and forming the hill at the head of Port Coldwell harbor. The study of the two end types shows that while the rock of the big hill is preponderatingly composed of light colored constituents, natronorthoclase and nepheline with subordinate amounts of colored minerals, chiefly brownish green hornblende with some aegerine-augite, the rock in the immediate vicinity of the station is about equally divided between dark and light colored constituents, the dark mineral being chiefly diopside, with a relatively small amount of brown hornblende and a great deal of associated magnetite, while the feldspars are of the orthoclase variety with very much less associated nepheline. Small biotite crystals are also common in the latter rock, as well as large fresh apatite crystals. It is evident from relations observed in the field that the rock richer in nepheline solidified later than the darker colored variety, as small off-shoots or dikes of the former are found in the latter, although one rock as a whole changes by gradual transition to the other. Similar relations were observed between the hornblende syenite and the nepheline syenite in this neighborhood, discussion of which will be taken up later when describing the hornblende syenites.

In many cases, particularly north of Mile Post 78, a white alkali syenite, with a semi-porphyritic structure, forms an intermediate type between the red hornblende syenite and the nepheline syenite. In this rock the feldspar is usually present in fairly well-developed lath-shaped crystals, while nepheline is rather an accessory mineral.

A White Feldspathic Variety on Pic Island

A very striking rock which is closely related to the nepheline syenites occurs about the centre of Big Pic island, where it occupies the top of the highest hill. This hill, as a matter of fact, is the highest elevation in the whole country around Coldwell, being

over 800 feet above the lake level, and forms a conspicuous mark in the topography of the country when viewed from the lake or from the low-lying region in the neighborhood of Peninsula. One of the most noticeable features of the whole area, indeed, is this distinctly greater elevation of nepheline-bearing rock when compared with that of any other part of the district.

In hand specimens this rock bears a marked resemblance to a specimen of Litchfieldite from Litchfield, Me., in the University collection, a resemblance, however, not borne out by closer study of the rock. The great preponderance of the white feldspathic constituents produces a very light-colored rock, which color is accentuated by the fact that the dark minerals are segregated in small groups. Small specks of hydronephelite spreustein are sparingly present. The feldspars have in many of the crystals well-developed lath-shaped forms, which tend at times to the semi-porphyritic appearance so common in many of the rocks in the district. The rock is rather coarse-grained.

Under the microscope the chief feldspar is seen to be subhedral orthoclase, but in some of the sections albite appears to occupy just as important a place. Microperthetic intergrowths of the two feldspars are common, but the banded appearance of the albite in the orthoclase when the former is arranged parallel to the orthodiagonal of the latter —a condition which obtains in so many of the rocks of this group—was seldom observed in sections of this particular syenite.

Microscopic crystals of hornblende are found sparingly as inclusions in the feldspar.

As stated above, the dark minerals are collected in groups. The chief dark constituent is a deep brown hornblende, which is probably the same mineral as described in the more typical nepheline syenites. In many sections it appears practically opaque.

Ordinary brown biotite is usually associated with the hornblende. A few small fragments of muscovite were also observed.

One small crystal of augite in the centre of a hornblende fragment was the only pyroxene seen.

Magnetite and apatite are conspicuous associates of the hornblende and biotite.

Nepheline is of very secondary importance, occurring only in isolated grains of microscopic size among the feldspar crystals. Indeed, very little fresh nepheline was observed, it being usually broken up into its characteristic decomposition products.

Here, as elsewhere throughout the district, magmatic differentiation has resulted in dividing the rock into zones occupied by variant types, which, however, are bound together through a gradation of intermediate types. This particular rock forms the top of the hill referred to above; about half way down it has gradually given place to a light brown colored rock which is made up largely of the same constituents, but with a great deal of finely divided iron ores scattered throughout the feldspars, and further characterized by the total absence of nepheline. This brown rock then gives place by gradual transition to the typical red hornblende syenite found on the lake shore. Apophyses of the nepheline syenite are found cutting the dark colored rocks, proving that it was the last to solidify.

The chemical composition of the rock proves it to be closely related to the true nepheline syenites.

Analysis of White Feldspathic Nepheline Syenite

	I.	II.	III.	IV.
SiO_2	60.07	60.03	60.39	60.92
Al_2O_3	19.79	20.76	22.51	21.34
Fe_2O_3	0.21	4.01	0.42	....
FeO	4.80	0.75	2.26	3.44
TiO	0.49	....	....	....
MnO	0.43	Trace	....	....
CaO	2.27	2.62	0.32	1.34
MgO	0.55	0.80	0.13	0.16
K_2O	4.54	5.48	4.77	6.33
Na_2O	6.23	5.96	8.44	6.02
H_2O	0.48	0.59	0.57	0.60
P_2O_5	....	0.07	....	....
Total	99.86	101.07	99.81	100.15

I. Analysis of white feldspathic rock, from Pic Island, made by E. L. C. Forster, M.A.
II. Analysis of Pulaskite (light colored), from Fourche Mountain, Arkansas, Annual Report, State Geologist, 1890, Vol. II. page 70.
III. Analysis of Litchfieldite, from Litchfield, Me.; G. S. A. II., page 241.
IV. Analysis of nepheline syenite (trachytic type), from one and one-half miles north of Mile Post 78 on C.P.R., by E. S. Moore, B.A.

Distribution of the Nepheline Syenites

The largest body of these rocks located is in the immediate neighborhood of Port Coldwell. They practically surround Coldwell harbor, and extend from this station in an easterly direction as far as Red Sucker bay, and form the bulk of the rock in this neighborhood, as seen on several short trips to the north. They occupy the coast line in places along the east and south side of the Coldwell peninsula, while a large body was located in the western part of the same peninsula. The two lines explored from Big Pic channel to the railway track would indicate that they occupy a considerable portion of the interior of the same region. North of Mile Post 78 large areas were also located as far north as the fifth mile on this line. The most typical nepheline syenites found on Big Pic island extend from the foot of South Bay as far west as explored. The northeast coast of the island is also largely occupied by nepheline rock, but of a somewhat less pronounced type, while most of that part of Little Pic island visited is also made up of the same eruptive.

Throughout the areas mentioned, while nepheline syenite is the largely predominating rock, other types are also present, but in greatly subordinate proportions. It is practically impossible, however, to indicate on the map sharp lines of demarcation.

Wherever the nepheline syenites were seen and it was possible to estimate the relative ages of the various rocks, the former were always found to be the youngest. Small dikes and off-shoots of the nepheline rock penetrate any and all other of the associated rocks with which it is in contact. This does not apply to the later eruptives which cut not only the nepheline syenites, but all the other rocks of the massif in numerous fine-grained dikes, the discussion of which will be deferred to a later part of this paper.

Red Hornblende Syenite

In the second rock cut west of Coldwell station a body of red syenite begins, which continues with interruptions for the next two miles along the railway track. The same rock occurs in considerable mass north of Mile Post 78 along the line explored in that neighborhood.

Between Coldwell station and the big nepheline syenite hill to the east occurs a small body of the same rock, which extends to the north with interruptions of the more sodaliferous eruptive as far as explored. Small areas are also found beyond Mile Post 78 towards Middleton, as well as along the lines explored through Coldwell peninsula. The same, or a closely related type, has been observed in several places on Pic island. Finally, in the region around Peninsula, and north of it, small sections are occupied by the same rock.

There is a great amount of variation in the red syenite, and the area of this rock shown on the accompanying map is not by any means occupied by it exclusively, but in all these sections it appears to be the preponderating rock. It is frequently associated with the dark augite syenite described below, and passes by insensible gradations into it. Good examples of this differentiation are found west of Coldwell station in the second rock cut, and in other places between this and Middleton.

In fact, a great deal of the rock along this part of the C.P.R. tracks is composed of the dark augite syenite, but its occurrence is of such an irregular nature that it was found impossible to separate the two on the map.

Then again, where the red syenite is associated with the nepheline syenite, a transition exists from the one to the other, a few of the salient features of which will be noted below.

This red syenite is, as a rule, fairly coarse-grained, but in places possesses the structure of an aplite. It is usually deep red in color, but varies greatly in this respect as it passes into the darker laurvikite, or into the lighter colored nepheline syenite. As a general rule the feldspars make up five-sixths or more of the rock, and the darker minerals, excepting in the finer grained varieties, are seldom more than one-sixth of the whole. The lath-shaped development of the feldspars, so common in all the rocks of the Coldwell massif, is also characteristic of the hornblende syenite. This is especially true of the lighter colored types intermediate between this and the nepheline rocks.

Pegmatitic dikes of the red syenite occur, cutting most of the associated rocks or filling the contraction cracks in the main body itself. These dikes are usually less than a foot wide, and are especially noticeable at times for the scarcity of dark minerals. In such cases the feldspar crystals are two inches or more long and an inch in width.

Components of the Red Syenite

The rock is composed of feldspar and hornblende with varying amounts of biotite, augite and sphene. Apatite and magnetite are the chief accessory minerals.

The feldspar is not by any means uniform in composition, but varies from orthoclase to microperthitic intergrowths of albite and orthoclase. In many cases orthoclase is the predominating mineral. This is true of the rock just east of Coldwell station, some of the syenite on the north side of Pic island, and a great deal of the rock north of Mile Post 78, as well as some of the red syenite west of the Pic river. On the other hand, the red syenite associated with the laurvikite west of Coldwell station is chiefly microperthitic intergrowths of albite and orthoclase, with individual crystals of these in subordinate quantities. The same relations are also seen in the syenites at the head of South Bay on Pic island, as well as in many other parts of the region.

These intergrowths are much the same as seen in other rocks of the area, excepting that true natronorthoclase does not appear to be present in many of the sections, and also in the general absence of a banded arrangement of the albite in the orthoclase where the former is parallel to the orthodiagonal of the latter. Very often the same crystal of orthoclase contains small inclusions of albite with the twinning lamellae, in some cases, parallel to the c axis, and in others parallel to the b axis—a combination of the albite and pericline laws. Subhedral crystals are seen only in those places where a semi-porphyritic development has taken place. The feldspars are usually deeply colored by clouds of hematite inclusions. Indeed, at times the crystals are almost opaque even in thin sections, owing to the great amount of this iron compound present.

Hornblende is the chief dark mineral, but it is always greatly subordinate in amount in all the coarser textured varieties. In some of the finer grained rocks, it is a more important constituent. It is always in anhedral grains, usually grouped with the other dark minerals. It is strongly pleochroic with the following relations in a typical example from near Coldwell station.

Parallel $\mathfrak{a}$ yellowish green.
Parallel $\mathfrak{b}$ chestnut brown.
Parallel $\mathfrak{c}$ light olive green.
with absorption: $\mathfrak{b} > \mathfrak{c} > \mathfrak{a}$

It is undoubtedly closely related to the barkevikite of the nepheline syenites. Occasionally green diopside is seen as an inner kernel in the amphibole crystal. Apatite in large, clear crystals, and magnetite grains are always present in large amounts as inclusions. Sometimes the hornblende is practically opaque, and almost black in color.

Biotite is usually present in small amounts. It forms the chief dark mineral in some of the syenites at the head of South Bay on Pic island. It frequently contains lense-shaped inclusions of feldspar between the cleavage plates.

Pyroxene rarely occurs in any of the specimens studied, excepting as a kernel in the centre of the hornblende crystal.

Titanite, in euhedral crystals of characteristic shape, is frequently associated with the other dark minerals. It is very slightly colored.

A few grains of quartz are found in some of the sections, particularly to the north and west as the granite country is approached, or where the syenite is associated with the distinct quartz syenites.

Variant Nepheline Syenite Types

Although there is no distinct contact between the nepheline syenite and the red hornblende syenites as seen just east of Coldwell, the rock mass is differentiated into most distinct types, the extremes of which are separated by only a few yards. This gives rise to a great number of intermediate rocks, a description of which would carry us beyond the limts of a paper of this kind. On the one hand, we have the typical hornblende syenite, as described above, and on the other hand, the dark nepheline rock composed essentially of natronorthoclase, some orthoclase, microperthite, augite with the deep green aegerine borders, and subordinate quantities of hornblende and biotite, with varying amounts of nepheline filling in the interspaces among the other minerals, besides the ordinary accessory constituents.

A number of specimens collected three feet apart along the face of one of the rock cuts just east of Coldwell station shows the following changes in going from the hornblende syenite to the nepheline syenite. Augite gradually displaces the hornblende until it becomes the chief dark constituent. Biotite is a prominent mineral in the middle members of the series, and, while it occurs throughout, it becomes in both extremes subordinate to the hornblende on the one hand, and to the augite on the other. The feldspar, which in both extreme types is principally of the cryptoperthite variety, becomes in the intermediate type chiefly oliogoclase, with some more basic feldspar, and while in the hornblende syenite it is brick red in color owing to the presence of hematite inclusions, in the grey nepheline syenites these inclusions are entirely absent. In some of the intermediate species olivine is an important constituent.

In this particular nepheline syenite, the nepheline does not appear to be a very prominent constituent, and in some of the sections studied from the first rock cut west of Coldwell, it is entirely absent.

Accompanying the transition from the red hornblende syenite to the dark colored nepheline syenite, there is a most decided change in the sp. gr. of the rock, ranging from 2.64 in the red rock to 2.85 in the more basic end of the nepheline rock.

In one of the intermediate members of the series, a very interesting relation was observed between some magnetite and pyrite. An inner kernel of magnetite was enclosed by a border of pyrite, which in turn was surrounded by a fringe of biotite crystals arranged perpendicularly to the outer border of pyrite. Serpentine was also associated with the biotite. Fine examples of reaction rims between olivine and feldspar, similar to those described in connection with the basic rocks of the district, are found in those members of the series containing olivine.

Apophyses of the typical nepheline syenites of the big hill east of Coldwell station are seen cutting both the red hornblende syenite and the dark grey augite nepheline syenite, as seen in the immediate vicinity of Coldwell station. Wherever relationships were observed, the type of rock rich in nepheline is always seen to be younger than any associated rock.

Augite Syenite or Laurvikite

Probably the most interesting rock of the district is the dark augite syenite, which occupies so large a part of the country in the neighborhood of Peninsula. At the western side of the area near Middleton another considerable body of a closely related rock is found. Between Coldwell and the Little Pic river it also occurs associated with the red hornblende syenite already described. Indeed, in this locality it occupies a large percentage of the area along the C.P.R. tracks. Johnson's island, and the contiguous coast line of Coldwell peninsula, the other small islands in the neighborhood of Johnson's Harbor, the three islands northeast of Big Pic, and a part of the shore of the Pic itself, are also made up of a closely related dark syenite.

The rock varies in color from dark brownish grey to black in certain localities, while in other places it ranges from reddish grey to dull red, accompanied in many cases, as seen just west of Coldwell, by an intermediate dull soapy brown rock. The dark grey to black type is the most prevalent. The most striking feature of the syenite in the field is the extraordinary plate-like, or lath-shaped development of the feldspars, which, in the freshly broken rock are strongly marked out by their bright shining cleavage surfaces. While this peculiar development of the feldspars is a common characteristic of the rock from all the above mentioned localities, it is especially well shown in the rocks from the Peninsula neighborhood The feldspars are by far the most important constitutent, and owing to their dark color, the relatively small amount of ferro-magnesium mineral is not readily noticed, except where the feldspars have become bleached by the weather.

The rock is as a rule fairly coarse textured, the feldspar crystals being from a quarter to a third of an inch long, and from less than one-tenth to a quarter of an inch wide. In the finer grained varieties, the feldspars, although still possessing an idiomorphic development, are much smaller, with the two dimensions more nearly equal. Coarse-grained pegmatitic developments are seen in the main body itself as well as in narrow dikes. These evidently represent the last portions to solidify.

The general appearance of the typical rock is much the same as certain hand specimens of the Norwegian laurvikite which are in the University of Toronto museum. Usually the Coldwell rock is not nearly so coarse grained as the specimen seen of the Norwegian syenite.

As the writer has not seen the Norwegian rock in the field, it is possible that the hand specimens in the University collection, as well as the type of rock exported for building and monumental purposes, represents the more coarsely grained, and most readily marketable varieties, and that the main body of the rock is not greatly different in texture from the body of the Peninsula syenite. The Lake Superior rock may show upon closer investigation, areas just as coarsely textured as the examples of the original laurvikite mentioned.

Both in general appearance and, as will be shown below, in mineralogical and chemical composition, this rock bears a striking resemblance to the famous Norwegian laurvikite.

Mineral Components of Augite Syenite

The mineral constituents of the rock consist of feldspar, pyroxene, a subordinate amount of amphibole, biotite and olivine, with magnetite and apatite. Pyrite occurs sparingly.

The feldspar is much the same as a great deal of that seen in the other rocks of the region, and closely resembles that of the Norwegian laurvikite. It is chiefly a microperthitic intergrowth of albite and orthoclase, similar in character to that already described from the associated rock. True natronorthoclase as well as orthoclase and plagioclase are also found, but in subordinate amounts. Plagioclase is a more common constituent of the type occurring in the western part of the area.

Inclusions and stains of iron oxides and small crystals of pyroxene give the feldspars a dark color.

Natronorthoclase from laurvikite, near Peninsula.

Feldspar from the augite syenite (laurvikite).

Analysis of Feldspar in Angite Syenite

The analysis of the feldspar from a rock collected near Peninsula gives:

—	I.	II.	III.
SiO_2	64.11	66.08	66.95
Al_2O_3	20.31	18.77	17.87
Fe_2O_3	0.18	....	0.90
CaO	1.61	0.37	0.52
MgO	0.30	....	0.24
K_2O	7.08	7.68	7.82
Na_2O	6.16	6.54	5.20
Loss in ignition	0.10	....	0.30
Total	99.85	99.44	99.80

For purposes of comparison, analyses of similar feldspars from other regions are also given. Number one is an analysis of a more or less homogeneous crytoperthite.

I. Analysis of feldspar from Peninsula rock, by H. L. Kerr.
II. Analysis of feldspar from Fredriskvarn, Norway, by G. Flink.
III. Analysis of feldspar from Fourche Mt., Arkansas, by G. W. Noyes.

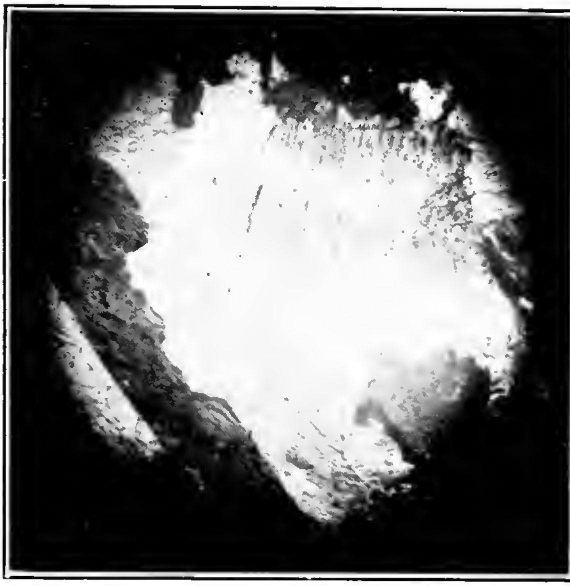
Feldspar in laurvikite.

A comparison of the above resnlts shows the close relation existing among the feldspars from the three localities.

Pyroxene is always the chief dark mineral. While idiomorphic forms are by no means rare, subhedral crystals are more common. The augite varies in rocks from different parts of the field. In the Peninsnla district it is of a composite nature, consisting of a pale brown interior, with a deep green border, and is undoubtedly one of the aegerine-augite series. While the deep green part of th crystal is usually confined to the border, yet in many cases patches of the green are often irregnlarly scattered throughout the crystal, or again, the whole crystal may be more or less uniformly of a deep grass green color. Pleochroism is most marked in the deep green borders of the crystal. The following relations were observed in a specimen near Peninsula:—

Parallel $\mathfrak{a}$ deep grass green.
Parallel $\mathfrak{b}$ pale green.
Parallel $\mathfrak{c}$ yellowish green,
with absorption $\mathfrak{a} > \mathfrak{b} > \mathfrak{c}$

The characteristic augite cleavage is well developed. The extinction angle varies with the composition of the pyroxene, but that of the deep green parts of the crystal is always noticeably lower than the brownish interior. For instance, certain measurements show the inclination of $a \wedge c$ to be 41° in the brown interior, while in the border and deep patches of the crystals $a \wedge c$ was 26°. Other measurements gave $a \wedge c$ 45° and 30° respectively. In these sections which do not show the maximum extinction there is always a marked difference between the border and the interior. The mineral is optically positive.



Feldspar from augite syenite.

An analysis of the pyroxene from the rock occurring at Mile Post 63 gives the following results:—

SiO_2	45.38
Al_2O_3	14.05
TiO_2	1.14
Fe_2O_3	8.21
FeO	12.27
CaO	14.06
MgO	1.46
Na_2O	1.80
K_2O	0.86
H_2O	0.86
	100.09

Sp. gr. 3.55.

The above analysis was made by D. E. Beynon, B.A.Sc. of the School of Practical Science, Toronto.

In the dark syenites between Middleton and the Little Pic river, the augite is distinctly different from that found in the Peninsula type. It is uniformly of a pale violet color, and weakly pleochroic, similar to that found in the olivine gabbro of the same part of the district. It is never in well formed crystals. Sometimes it is bordered by a rim of barkevikite. Characteristic pyroxene cleavages are not nearly so well developed as in the pyroxene found in the eastern part of the area. It carries numerous inclusions of apatite, magnetite, and biotite, and possesses the characteristics of ordinary augite. In the neighborhood of Coldwell, much of the pyroxene in this augite syenite is the same violet augite with hornblende borders. In the western part of the

Peninsula occurrences of laurkivite, diopside is a common constituent, and is frequently surrounded by a narrow rim of hornblende, which is partly of a dark brown barkevikite type, and partly of a bright blue arfvedsonite.

While the rock from the region of Johnson's island appears in hand specimens to be identical with that from other parts of the area, it has as a matter of fact in the specimens collected very little of the ferro-magnesium minerals, and indeed the dark brown hornblende seems to replace the augite almost entirely. It is just possible, however, that the specimen brought from this region is not a representative one.

An Interesting Olivine Type

While olivine is found in this rock, chiefly in the neighborhood of Middleton, yet it occurs sparingly in all the rock from the other localities. A very interesting type is a prominent constituent of the laurvikite in the neighborhood of Peninsula. Olivine found in the Middleton district is the ordinary kind, usually quite fresh, and requires

Laurvikite, showing augite, olivine and feldspar.

no particular comment. In the last rock cut along the C.P.R. tracks, east of Peninsula in the neighborhood of Craig's gravel pit, is an olivine somewhat unusual in appearance. It was mentioned by Dr. Adams in his description of the hand specimens from the Ottawa Museum collection, but was not named.[14] The writer sent the specimen through Prof. Walker to Dr. Brögger of Christiania, who states in his report: "The yellowish mineral in question is without any doubt an olivine (chrysolite), rich in iron. Extinction parallel; optic character negative; 2E ca. 100°, 2V ca. 60°; birefringence rather strong; dispersion of the optic axis high: $2V\rho > 2V\upsilon$ for bisextrix α etc. This olivine mineral corresponds very nearly with the olivine of the laurvikite of South Norway."

Less than one-quarter of a gram of this mineral was isolated for the purpose of making chemical tests, which, however, were not very successful, and as no more of the pure material could be obtained, although a couple of days were spent in Peninsula searching for it, no further chemical tests were made.

[14]Am. Journal of Science, Vol. XLVIII., July, 1894, pp. 10-18.

The larger pieces in reflected light are a pale green, in transmitted light amber yellow in color.

The mineral has a distinct resinous lustre and conchoidal fracture, and has a hardness of 5 to 5.5. In thin sections it is pale yellow in color. It has high relief, and is strongly doubly refracting. It always occurs in a hyphidiomorphic form, closely associated with the pyroxene. It is usually badly broken up by fracture planes which do not appear to have any definite crystallographic relations. The mineral is readily attacked by hydrochloric acid, leaving a white residue. Under the microscope between crossed nicols it has much the appearance of titanite.

As stated above, hornblende occurs sparingly in all the sections of these rocks. It is for the most part the ordinary brown barkevikite, similar to that described from the nepheline syenites. However, small quantities of arfvedsonite are found usually in irregular scales associated with the other dark constituents. In one section of the rock from the neighborhood of Peninsula, a small basal section of riebeckite was noted, which was readily recognized by its deep blue pleochroic color.

Biotite occurs sparingly, and is characterized by a deep chestnut brown color, and strong pleochroism. Besides this ordinary brown biotite, a rather interesting mica occurs in the laurvikite between the quartz syenites east of Red Sucker and the eastern limits of the massif. It occurs in small fragments of a marked brownish red color. Dr. Brögger kindly examined this specimen also, and says: "The mineral in question is probably a mica with 2V nearly equal to O°, cleavage perfect; extinction parallel to the cleavage; perpendicular to the cleavage, a negative opic axis; uniaxial; pleochroism very strong; γ greenish black or dark olive green; α red brown to yellowish brown; sections parallel to the cleavage without pleochroism, greenish brown; birefringence high. Rosenbush-Wulfing (Miks. Phys., Vol. I., Part 2) mentions a biotite with nearly corresponding pleochroism." Another of the minerals which occurs in sections from the same locality is considered by Dr. Brögger as belonging to the same mica as that just described. He remarks regarding it: "The yellowish mineral in question is in some sections uniaxial, negative; $\gamma - \alpha$ perhaps about 0.02 - 0.03. Other sections are biaxial. Some sections are pleochroic with α brownish red γ greenish black. Occasionally these pleochroic sections are surrounded by a yellowish isotropic or nearly isotropic substance, which is probably a decomposition product."

Magnetite, pyrite and apatite occur in varying amounts, associated with the other dark constituents, but possess no features worthy of special note.

Fluorite. Grains of fluorite are very occasionally seen as bluish, isotropic fragments among the other constituents.

Quartz occurs sparingly in certain parts of the field, but in the typical rock from the neighborhood of the Peninsula it is entirely absent.

The chemical analysis of this rock shows that it is closely related to the laurvikite of Norway. For purposes of comparison, analyses of the laurvikite are associated with those of the Coldwell variety. The rocks analyzed were those collected near Peninsula, which the writer considers the type of rock most closely resembling the original laurvikite.

Analysis of Augite Syenite

	I.	II.	III.	IV.
SiO_2	58.37	58.81	58.88	50.19
TiO_2	0.97	0.70	....	1.32
P_2O_5	0.21	0.31	.54	0.22
Al_2O_3	15.11	14.37	[illegible]	17.43
Fe_2O_3	1.91	3.88	[illegible]	2.16
FeO	8.99	6.97	2.58	7.80
MnO	0.48	0.20	....	Trace
CaO	3.32	3.89	[illegible]	3.29
MgO	0.57	0.51	[illegible]	....
K_2O	4.99	5.42	4.5[illegible]	....
Na_2O	3.76	4.96	5.73	....
Moisture	2.25	1.04	1.[illegible]	....
Total	100.03	100.06	100.[illegible]	....

I. Analysis of the laurvikite from near Peninsula, by F. A. Ghent Philadelphia
II. Analysis of a similar rock from near Peninsula, made by A H. A. Robinson, of the Chemical Department of Practical Science, Toronto University.[1]
III. Analysis of Norwegian laurvikite from Byskoven, Laurik, by A. Merian.[2]
IV. Partial analysis of laurvikite from near Peninsula, containing a great deal of the yellow iron rich olivine, made by E. S. Moore, B.A.

In several of the rock cuts between Port Coldwell and the Little Pic river, variations are noted from a dark greenish grey rock closely resembling in appearance the laurvikite just described, but with a less pronounced idiomorphic development of the feldspars, through a soapy yellow colored rock of similar structure, to the ordinary red hornblende syenite. All these rocks as a rule are much less coarsely grained than the typical laurvikite. Under the microscope it is seen that they are composed chiefly of microperthite, similar to that found in the rocks all over the region, the regular dark hornblende, a very little augite, iron oxide, and quartz. The red variety has only odd grains of quartz, but the darker colored types have so much of this mineral that they might reasonably be classified as quartz syenites. Indeed, in one place on the accompanying map, such an area is indicated in this way. However, they all seem to be more closely related in constitution to the dark augite syenite than the former rock.

Quartz-bearing Rocks of the Coldwell Area

Quartz Syenites

The chief quartz-bearing rock of the region is found east of the Red Sucker. It occupies all the district south of the C.P.R. in this section, to within a short distance of Munro Bay. To the north of the track it extends for a distance of from two to three miles. Beyond Munro Bay to the east, it forms the long, narrow peninsula which is the northwest boundary of Peninsula Harbor, as well as the island upon which the lighthouse stands, and the large island in the harbor itself. To the west the same rock is found on Detention island, while Gull Rock is also formed of quartz syenites. Most of the shore of the northwest bay on Pic island, as well as the mainland immediately north of this, is occupied by a somewhat different but related rock.

These quartz syenites are not by any means uniform in appearance, or in mineralogical composition. The predominating color is dark red, a rock of this type occupying most of the district in the neighborhood of Red Sucker, and the two islands mentioned above in Peninsula harbor. Particularly towards the east it is much darker in color, and of a distinctly green shade. The transition from one type to the other is gradual.

The texture of the rock is medium grained granitic, with a more or less trachytic structure developed in places in the darker variety. It is characterized, especially in the red rock, by its extreme brittleness, which gives rise to great talus deposits at the base of some of the cliffs, a good example of which is seen just west of Munro Bay to the north of the railway track.

[1]Rep. Bur. Min., 1902, p. 211.
[2]Ibid, p. 211, cited from Zeitschrift fuer Kryst. u. Min. Band 16, 1890, p. 30.

The Red Sucker quartz syenite appears to be made up of rusty red feldspar and hornblende, with in most places a very little quartz.

Under the microscope it is seen that the chief mineral of the rock is feldspar, which as a rule is deeply colored by hematite, which is frequently segregated along cleavage cracks. The feldspar is mainly microperthitic intergrowths of plagioclase (chiefly albite) and orthoclase, and closely resembles the cryptoperthite of some of the nepheline rocks. The crystals are not as a rule present in well developed forms. Besides the albite twinning of the plagioclase, Carlsbad twins are quite common. Inclusions of hornblende, magnetite and hematite are abundant, while fluorite is seen occasionally.

Quartz is always present in polyhedral grains as a subordinate constituent filling in between the earlier formed crystals. Occasionally it is seen graphically intergrown with the feldspar. The amount of quartz varies very much in different parts of the field.

Lighthouse Island, Lake Superior.

The chief dark mineral of the rock is hornblende, but it is, as a rule, so badly broken up that very little can be made of it. In the less decomposed crystals, however, it appears to be more closely related to the green hornblende of the nepheline syenities. Decomposition has gone so far in many cases that all that is left to indicate the original hornblende crystals are grains of magnetite and stains of serpentine.

Biotite scales are found sparingly associated with the hornblende in some of the sections studied.

Magnetite is very plentiful, and owes its origin chiefly to the change which has taken place in the hornblende.

Hematite is present in large quantities finely scattered throughout the feldspar crystals. Indeed the feldspars are at times so dense from the presence of the hematite that even in thin sections they are practically opaque.

Pyrite in irregular grains is seen occasionally. Apatite is one of the common accessory minerals. Fluorite was found in the rock from Lighthouse island as small inclusions in the feldspars. Secondary calcite also occurs sparingly.

While the chemical analysis of this rock shows that it is not very closely related, as was at first suspected, to Brögger's nordmarkite, yet it bears a striking resemblance to the nordmarkite described by Szadeczky from Ditro Siebenburgen, Hungary, and should undoubtedly be associated with these quartz syenites.

Analysis of Quartz Syenite

	I.	II.	III.
SiO_2	58.60	60.45	62.52
Al_2O_3	19.94	20.14	23.54
Fe_2O_3	4.25	3.80	2.15
FeO	2.42	....	1.38
CaO	2.76	1.68	1.65
MgO	1.71	1.27	0.26
K_2O	4.84	7.23	4.02
Na_2O	3.21	5.12	4.16
H_2O	2.29	0.71	0.03
Total	100.05	100.40	99.71

I. Analysis of quartz syenite just east of Red Sucker.
II. Red quartz syenite, from Hillestadvand, Norway, Zeisch. F. Cryst. XVI., 54, 1890.
III. Nordmarkite, from Ditro Siebenburgen, Hungary, J. Szadeczky, N. J., 1901, I., p. 402.

Towards the eastern part of the area defined above, likewise on Detention island, the rock in places is very much darker in color, and whereas in the red, more acid type the feldspars form the bulk of the rock, the darker variety is made up more largely of ferro-magnesium minerals. On the weathered surfaces it usually presents a dark green appearance.

Under the microscope the rock shows much less quartz. It presents the same general characteristics as the quartz of the red rock, being occasionally graphically intergrown with the feldspar, but ordinarily in angular fragments filling in among the other constituents.

The predominating feldspar is also plagioclase of the albite-oligoclase variety. Both the orthoclase and plagioclase are full of inclusions of magnetite, hematite and hornblende.

The hornblende is the same as that of the nordmarkite, but in subordinate quantity, and shows the same tendency to decomposition. Besides this green hornblende, there is also the ordinary brown amphibole present.

A light colored augite is the most prominent bisilicate. It forms an important part of the whole rock. The crystals are usually surrounded by a border of secondary hornblende. Occasional scales of biotite are associated with the other dark constituents. Magnetite is more abundant than in the red quartz syenite.

Apatite crystals are here larger and more plentiful also.

Other Quartzitic Rocks

In places along the coast east of Red Sucker, this eruptive passes into a dark dioritic rock, with more basic plagioclase and very few grains of quartz. Indeed, within this body there appears to be evidence of the same differentiation as in the other rocks of the area.

A somewhat different type of quartz syenite is found on the shores of the northwest bay on Pie island, and on the mainland to the north. In color it varies from red and pink to brown and grey. It is fine to medium grey with more or less porphyritically developed feldspars.

Under the microscope they are seen to be made up of quartz, microperthite, hornblende, magnetite, and some pyrite and hematite.

The quartz is characterized by angular polyhedral forms, being the last constituent to crystallize.

The feldspar is a microperthitic intergrowth of orthoclase and albite, and makes up the bulk of the rock. Well developed euhedral crystals are common. Carlsbad

twins are numerous. The potash feldspar is not always the chief part of the crystal, for the plagioclase frequently predominates. All intermediate stages are found. Inclusions are very numerous, chiefly hematite, although both magnetite and hornblende are plentiful. The hematite is often aggregated in considerable quantities, and in places practically displaces part of the feldspar. As a rule these aggregations occur along the cleavage cracks.

Deep green hornblende in irregular scales and broken up crystals, sometimes poikilitically intergrown with the feldspars, is the chief colored mineral.

Fragments of biotite sparingly occur in association with the hornblende. Magnetite, some pyrite and, in certain varieties, limonite are found, besides a few crystal fragments of fluorite, and secondary calcite.

A rather curious quartz syenite occurs about half a mile west of Coldwell station, along the railroad track. It has the general appearance of an ordinary red syenite until closely examined, when it is seen that the feldspar has a rather curious structure. It is made up of a greenish grey variety often enclosed in lens-shaped masses in a brick red variety. This at once suggests the Rapikevi structure. The red variety is perhaps the more plentiful of the two.

Under the microscope it is seen that the inner kernel is also composite, being made up of ordinary orthoclase and plagioclase, probably oligoclase, pegmatitically intergrown. The twinning lamellae show very indistinctly, making an absolute diagnosis of the feldspar rather difficult. The red feldspar which surrounds this inner kernel is partly microcline, and partly oligoclase. Magnetite, hornblende, and biotite inclusions are numerous.

Ordinary hornblende is the chief dark colored mineral. Brown biotite is usually associated with the hornblende. Magnetite, leucoxene and pyrite are present in subordinate quantities, with the former predominating. Apatite is commonly associated with the dark colored minerals in great quantities. Angular fragments of quartz are sparingly scattered throughout the rock. Calcite is more plentiful than the quartz, commonly occupying the greater part of the space filled originally by hornblende crystals.

Granites

The least important rocks of the area mapped are the granites which occur in the neighborhood of the Little Pic river. This river, which is only about a chain wide at its mouth, is the only stream in the district which can be explored by means of a canoe. It is shallow throughout. On both sides of it abrupt hills, 150 to 200 feet above the lake level, parallel the stream. In the lower stretches of the river it flows at the foot of these hills, but to the north the river valley broadens, and beyond the portages mentioned below it becomes quite extensive. The hills on the east side of the stream are lower, and for the most part farther back from the river banks. About two miles from the lake shallow rapids are encountered, which continue with few interruptions for the next four miles, making canoeing difficult. Two short portages on the east are cut past the heaviest part of these rapids. Beyond this, according to the Indians met in the neighborhood, many miles of quiet water obtain, leading to numerous small lakes in the granite country, as indicated on the map of the Geological Survey accompanying the reports of Wilson and Collins. The lower part of the river passes through red hornblende syenites, which are succeeded one and one-half miles from its mouth by granites. These granites, with one small interruption of syenites, obtain continuously from here north as far as explored, and, as shown by the report of Collins mentioned, are the beginning of an extensive area of granites and granitoid gneisses.

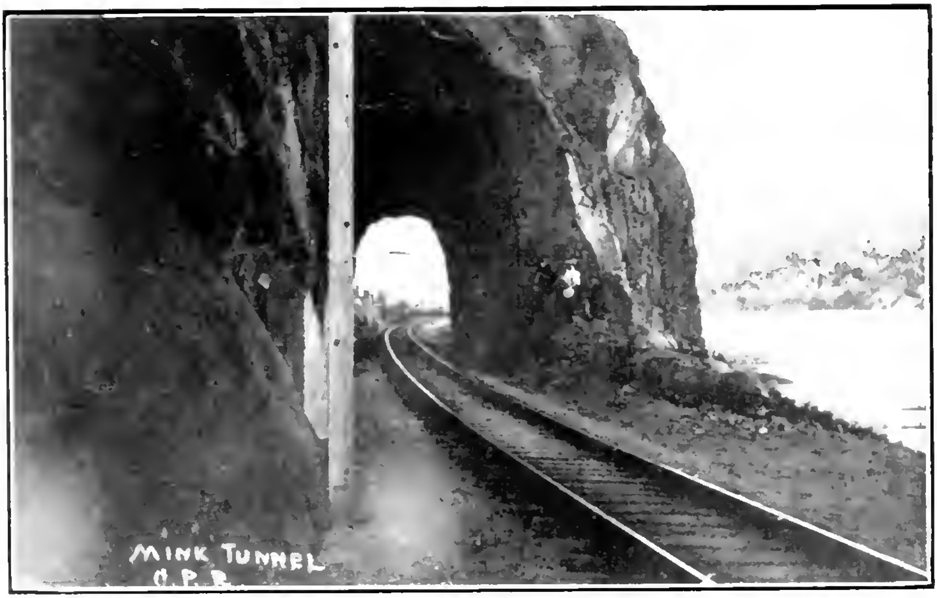
The granites are medium grained rocks, varying in color from dark red to dark grey, with some varieties pale pink to white in hue. They consist essentially of feldspar and quartz, with very little ferro-magnesium minerals. The feldspar is generally a microperthite intergrown similar to that found in other rocks in this region. However, in some of the granites oligoclase, with a very little orthoclase, makes up the bulk of the rock. All the rocks of this type are characterized by the small proportion of dark

minerals which they carry. In some, small scales and irregular fragments of hornblende associated with magnetite sparingly occur. In such rocks hematite is found in large quantities as an inclusion in the feldspar; pyrite also exists in some of the types. In the lighter colored rocks biotite, with very little iron ore, appears to be the only dark constituent. The biotite, however, never has the deep chestnut brown color seen so frequently in the syenites already described. Quartz is the last mineral to crystallize; it forms a large part of the whole rock, but possesses no unusual characteristics worthy of note here.

So far as seen on the hurried trip up the river, the syenites pass insensibly into the granite.

Chief Basic Rocks of the Region

A short distance west of Red Sucker and between the quartz syenites and the nepheline syenites, is a small area occupied by a darker basic rock resembling gabbro. It extends south of the track nearly to the mouth of Red Sucker bay, while to the north it is the chief rock on both sides of that part of the bay cut off by the railroad, with an



Mink Tunnel, Lake Superior.

unknown extent to the north of this. From a little west of Mink tunnel it follows the shore line, as indicated on the map accompanying this report, to Coldwell harbor, and from the harbor with interruptions of nepheline syenite along the east side of Coldwell peninsula to its southeast projection, besides occupying most of the several small islands between Detention island and the mainland. A considerable area of the rock is found on the west side of the peninsula, as well as in the interior of this same region, as seen on the two lines explored from Pic channel.

Somewhat different rocks of the basic variety occur in the line explored north of Munro bay, beyond the syenites. Between Mile Post 78 and the Little Pic river, a still more basic type approximating true picrite is found, while just east of Middleton station a small body of olivine gabbro occurs.

Besides these particular sections, small bodies of basic rock are found associated with the other rocks of the region in many places which cannot be detailed here.

In numerous localities, especially east of the Little Pic along the railway track, and south of this in the interior of Coldwell peninsula, brecciated masses of these basic rocks are found where subsequent eruptives have carried off angular blocks of the older rocks, forming an interesting example of an eruptive breccia.

Wherever found they are seen to be older than any other rocks with which they are associated, and are undoubtedly the oldest rocks of the massif. Small dikes of associated eruptives pierce it in all directions.

Along the lake front in the neighborhood of Coldwell harbor wave action has honeycombed the rock by wearing away the less resistant constituents. In this respect it is very different from any other member of the association, as wave erosion in all other cases has produced rounded, smooth surfaces; in many instances, particularly among the dark syenites, preserving the roches moutonnées effect left by the glaciers. In the more exposed sections along the lake front small dikes of the more resistant acid rocks project a foot or more above the surrounding basic rock.

Gabbro, near Middleton.

The more common type, as seen in the neighborhood of Coldwell, is a holocrystalline, granitic, dark grey rock of medium texture, with gleaming outstanding crystals of biotite, and the dark minerals making up more than three-fourths of the whole.

Near the contact with the other rocks the composition varies greatly at times, due to the incorporation of some of the basic rock by the later more acid eruptives. For instance, where it approaches the red augite syenite the rock possesses a reddish tinge, and where the nepheline rocks are in contact it is distinctly lighter in color, giving rise to a small extent of intermediate types. This is not always true, however.

Composition of the Basic Rocks

Under the microscope the rock is seen to be composed of augite, olivine, biotite, hornblende, magnetite, plagioclase (Labradorite), some orthoclase, occasionally nepheline, and large quantities of magnetite, with apatite as the chief accessory mineral. While these constituents, with the exception of orthoclase and nepheline, are found in nearly all the sections, their relative amounts vary very greatly. For instance, some of the rock in the neighborhood of Coldwell harbor has very little plagioclase present, and is really a typical picrite, while again the constitution is that of a true olivine gabbro. In the neighborhood of Red Sucker parts of the mass have the composition of an essexite.

Augite is always the chief mineral present. It is usually in idiomorphic crystals, with the faces (100), (010) and (110) well developed. It is mostly of a pale green color, and faintly pleochroic. But in certain of the rocks near Red Sucker deep green diopside occurs similar to that of the nepheline syenites.

In some sections of the rock from near Red Sucker it is associated with considerable biotite, which occasionally is seen forming an interrupted border about the pyroxene, or included in the crystal itself. Zonal structure was observed in a few cases. Sometimes the outer edge of the augite has been changed into hornblende. The chief inclusions are apatite in large, clear crystals, magnetite, with very little pyrite, and biotite. Besides, certain sections from near Red Sucker, as well as that near Middleton, have innumerable small dark crystallites, probably ilmenite, arranged parallel to steep terminal planes, with a tendency to segregation in the centre of the crystals. Such sections have a distinct violet tinge. In many cases the pyroxene is practically free from inclusions.

Olivine is the next most important constituent, and is always present. It is usually colorless, but occasionally green, and almost invariably it occurs in irregular anhedra. Ordinarily it is rather fresh, but all stages of decomposition are found, from the thin fringe of serpentine surrounding the central crystal to the completely changed mass, where the olivine has been replaced by the resulting magnetite, serpentine and chlorite. Innumerable crystallite inclusions are frequently met, and are probably ilmenite. Iddingsite as a secondary mineral was seen in one place as fine parallel fibres about the exterior of the crystal.

Splendid examples of reaction rims about the olivine are found in many of these basic rocks. The inner rim consists of small crystal fragments of a colorless mineral possessing high double refraction. These are arranged more or less normally to the outer edge of the olivine. The mineral itself is probably tremolite. Outside of this a wider rim of deep green biotite is usually found. While these biotite fragments ordinarily are also arranged perpendicular to the outer edge of the olivine, yet occasionally crystals arranged at right angles to this are seen. The boundary between the tremolite and biotite is always sharply defined, but the biotite itself runs out irregularly into the surrounding feldspar.

Besides these two minerals, certain sections of olivine were observed which were perfectly fresh, but with a rather wide border of magnetite inside of the tremolite and biotite.

These reaction rims were not noted excepting where the olivine was originally in contact with the feldspar. Where olivine and augite were together, no reaction rim was noted.

Biotite is a most important constituent of these rocks. It appears under the microscope in large sections of irregular outline. The color varies from deep red brown, dark brown, brownish yellow, to pale yellow. It is strongly pleochroic in shades of the same color. It is usually subordinate in amount to olivine or augite, but in a specimen of essexite obtained just east of Red Sucker tunnel it is the most important mineral present. It has a very small optic angle, not more than 2° or 3°.

Ordinary brown hornblende was found in a few of the sections studied near Red Sucker, but it is frequently entirely wanting, and is by far the least important of all the colored minerals.

Serpentine and chlorite as secondary minerals are generally present in large amounts, associated with the olivine or augite.

In most cases plagioclase is the only colorless constituent present, with the exception of apatite. However, orthoclase and nepheline are found in greatly subordinate proportions in certain places near the nepheline syenites, both near Red Sucker and along the west side of the big peninsula.

The plagioclase occurs in xenomorphic to hypidiomorphic tabular fragments, occupying the interspaces among the more basic minerals. It is usually quite fresh. Besides the regular albite twinning, Carlsbad twins are common in some sections, while twin-

ning, according to the Manebach law, is also present. The feldspar is chiefly labradorite, but some anorthite is also found. Occasionally there is a more or less zonal growth of the one about the other, the more basic occupying the centre of the crystal.

Orthoclase in anhedral grains is not an important constituent, but is present in those rocks which carry nepheline. Nepheline in polyhedral fragments is found in certain rocks, both to the east and west of the main nepheline syenite. Numerous large crystals of apatite are always associated with the dark minerals. Magnetite in large irregular grains is an important mineral, and is chiefly associated with the other dark minerals. Pyrite is sparingly present in some of the sections. Epidote as a secondary product from the plagioclase was seen in some of the sections studied.

As mentioned above, the composition of different parts of this basic rock warrant different names. In the neighborhood of Red Sucker, and the western part of Coldwell peninsula, certain sections studied have the composition of essexites. None of the specimens resemble very closely any of the essexites the writer has seen from Norway, but there is a marked resemblance to a specimen in the University collection from Pommerle, Bohemia. A more careful study of the region would undoubtedly disclose essexite as a much more important part of the massif than at present known.

On certain of the little islands between Detention and the mainland the rock is a true picrite, being composed almost entirely of augite, olivine, and magnetite with very little feldspar. Picrite also occurs along the railway track east of the Little Pic river.

Just east of Middleton the chief basic rock is an ordinary olivine gabbro.

Diorite

About four miles and a half north of Munro Bay, along the line explored in that region, there appears to be a considerable area of fine grained biotite diorite. The same rock occurs about three miles and a half north of Coldwell station, and is undoubtedly part of the same body, as sections of rocks from the two localities are identical. In both places they are cut by the surrounding syenites. This diorite is composed of ordinary green hornblende, brown biotite, numerous crystal fragments of sphene, and a little magnetite and feldspar.

The only exceptional feature of any of these minerals is the prevalent zonal structures of the feldspars. Most of these consist of an outer border of albite with the innermost part of the crystal anorthite, with intermediate members of the series between, as indicated by the extinction angles.

In the neighborhood of Munro Bay a considerable body of fine-grained basic rock, which is difficult to place in relation with other members of the massif, is found. It is extremely fine textured, and has much the appearance of compact basalt. When seen along the railway track it is badly broken up by joint fissuring, and along the parting planes hematite has been developed in places to such an extent that the rock has much the appearance, upon first view, of an iron ore. Where it approaches the red quartz syenites the rock has a distinct reddish shade of color. Dikes of the syenite cut it in all directions, proving it to be the older of the two.

Under the microscope the following minerals are made out: Hornblende, magnetite, epidote and feldspar. Green hornblende seems to be decidedly the most important constituent. It occurs in microscopic grains and crystal fragments.

Epidote appears as if filling in cavities from which the original mineral has been displaced. It is readily recognized by its pleochroism and high polarization colors.

Plagioclase is partly idiomorphic and partly xenomorphic. Owing to the innumerable inclusions, the crystals are so clouded that their exact determination was impossible.

The feldspar is chiefly a matrix in which the other constituents are imbedded.

The chemical composition of this fine-grained basic rock places it among the more basic eruptives. The analysis was made by E. L. C. Forster, M.A., of Toronto University.

SiO_2	49.49
Al_2O_3	16.67
TiO_2	1.45
Fe_2O_3	4.35
FeO	12.71
MnO	0.35
CaO	3.98
MgO	2.21
K_2O	2.61
Na_2O	4.75
H_2O	1.51
	100.08

The Younger Dike Rocks of the Area

Besides the coarse grained pegmatitic developments found in all the rocks of the region, and already referred to, and the small off-shoots of the younger rocks found penetrating the older, numerous small dikes of later eruptives cut the massif in all directions. To describe these in detail would carry us too far, but for the sake of completeness a brief summary of the chief characteristics may be noted.

Pegmatitic Veins

One of the most noticeable features of all the rocks described, and particularly of the nepheline syenites themselves, is the great number of small veins of coarse-grained pegmatite which cut the body of the rock. These veins in the nepheline syenites vary from less than one inch to a foot or more in width, with the smaller veins greatly preponderating. They appear to be composed essentially of the same constituents as the body of the rock itself. They are not always found with well-developed borders, but pass gradually from the coarse-grained type found in the centre of the dike to the finer textured body of the rock.

The small quantity of dark minerals is a rather constant characteristic of these veins. The best development of the hydronepheline spreustein is always seen here, its bright orange red color making it the most conspicuous feature of the rock. It is here, too, that the feldspar crystals reach their greatest development. Hornblende, augite and biotite also sparingly occur. It is altogether likely that these veins represent the last stages of cooling in the rock.

Similar pegmatitic veins, consisting largely of feldspar, are found both in the red hornblende syenite and the augite syenite.

True Dike Rocks

Most of the dikes of the region are small, ranging from a couple of inches to four feet in width, with an occasional dike larger than this. In the field most of these dike rocks appear to be closely related in composition. This is borne out by a microscopic study. They are chiefly dark slate grey in color, and very fine-grained; some, however, are made up of slightly reddish colored rock. The larger dikes are intermediate in texture between the fine-grained dikes and the coarser country rock. Some show more or less porphyritic developments of different minerals. For the most part these dike rocks would be classed in the field as greenstones. Many of them are intermediate in composition between camptonites and essexites. It would be unprofitable to describe them in detail here.

Camptonites

The camptonites make up the principal dikes of the area. They are composed chiefly of hornblende, biotite and feldspar, magnetite, some pyrite, very little apatite, and secondary calcite. None of these minerals, however, possess any unusual characteristics worthy of note. The rocks are often uniformly fine-grained, but frequently phenocrysts of different minerals are found. These phenocrysts vary in different dikes;

sometimes they are composed of hornblende, in other parts augite, always in a fine-grained ground mass, consisting chiefly of plagioclase. Again, the rock is more uniformly of an intermediate texture, with the individual crystals of the varions constituents of about equal size. The feldspar at times possesses a more or less ophitic texture. Hornblende is usnally the most abundant mineral.

Dikes differing from these in the presence of olivine, which is usually replaced by calcite and chlorite, are quite common.

A rather interesting dike occurs cutting the red syenite near Mile Post 77. It is one of the larger dikes in the region, being about six feet wide. It is of intermediate texture and pale red color, and is composed of dark brown barkevikite, a very little biotite, deep blue riebeckite and feldspar. The feldspar is the chief constituent, and occurs in part in rather well-developed crystals, and partly as a fine granular material. It is made up of microperthite and albite. Besides this, a few grains of magnetite and fluorite are present. Quartz occurs sparingly. The chief interest attached to this particular dike is that it is the only place in the district where the deep blue pleochroic riebeckite was found in any quantity. This amphibole forms probably one-tenth of the rock. It is always in poorly developed crystal forms.

About a mile inland from Pic channel, on the most easterly line explored through the Coldwell peninsula, a rather interesting dike was found. The most prominent constituent in it is rather fresh olivine. In one place this olivine showed a fine development of the hour-glass structure. Usually a great deal of magnetite is associated with the olivine. Besides olivine, biotite in irregular fragments scattered throughout the rock, and almost colorless anhedra of augite together with basic plagioclase, more or less ophitically developed, make up the rock.

A small vein of rather pure natrolite was found west of Mink tunnel.

A number of fine-grained diabase dikes are also found, but they possess no features worthy of discussion here.

Relative Ages of Members of the Massif

According to Brögger, the rocks of the Norwegian nepheline syenite area were derived from a common magma basin through a succession of eruptions, beginning with the basic rocks and forming a continuous series to the most acid granites. He also states his belief that the later basic dikes found cutting the main rock mass represent the final depletion of the original magma basin.[15]

While the data obtained in the Coldwell district are most incomplete, and therefore unsatisfactory upon which to theorize, yet in some respects Brögger's conception of the origin of the Christiania rocks seems to hold true here.

Unquestionably the oldest rocks of this eruptive series are the basic picrites, gabbros, etc.; while it is just as true that the youngest rocks of the region are the narrow basic dikes.

In the neighborhood of Coldwell, and in two or three places on the Coldwell peninsula in particular, wherever coarse-grained basic eruptives were found, off-shoots and dikes of the associated rocks invariably pierce them. Several good examples of eruptive breccias occur towards the western part of Coldwell peninsula, where large blocks of the basic rocks were carried off by the later more acid eruptives; therefore there need be no hesitation in placing these basic rocks as the oldest members of the massif.

Next in age to the basic series Brögger places the laurvikites. The same age relations appear to hold for the Coldwell area. Wherever relationships were observed, however, between the angite syenites and the red hornblende syenites, off-shoots of the latter were found cutting the former. If we look upon this red hornblende syenite as a more or less variant type of the laurvikite (for everywhere they grade into one another), the two rocks would take up the same relative position in age as is found in South Norway. Off-shoots of these are found cutting the more basic rocks, while they are themselves pierced by dikes of the undoubtedly later nepheline syenites.

[15] Zeitschrift für Kryst. u. Min. Band 16, 1890, pp. 80-90.

Brögger has determined that his laurdalites are younger than the laurvikites, and older than all the succeeding acid rocks, including the ackerite, nordmarkite and granites. Similarly in the Port Coldwell massif the various types of nepheline syenite are younger than the augite and hornblende syenites. Off-shoots from the main nepheline syenite mass are always found penetrating the older basic rocks, the red hornblende syenite, or the laurvikite associated with it.

It is true also, as has already been pointed out, that innumerable transition types are found between the distinct nepheline syenites and the true hornblende syenites; also between the true hornblende syenites and the laurvikites, and in the main body of each individual rock a great deal of differentiation has taken place, giving rise to a number of variant types. But the evidence of the relative ages of the three main rocks is amply conclusive.

Brögger places his ackerite and nordmarkite next in age to the laurdalites, with the granites the youngest of all, excepting the later dike rocks. While I am inclined to think the same holds true for the Port Coldwell area, yet my data are not by any means complete. It is true that small dikes of quartz syenites were found cutting the laurvikite, and, as mentioned in an earlier part of this paper, certain rocks closely resembling the augite syenites have a composition intermediate between it and some of the quartz syenites of the region.

Only one dike containing quartz as an essential constituent was found in the whole region cutting the nepheline syenites. In the quartz syenites themselves, small dikes made up of more than 50 per cent. of quartz are found piercing the main body of the rock. One would almost be inclined to think, however, from their appearance that instead of these being off-shoots from later more acid types, they merely take the place in the quartz syenites of the pegmatitic contemporaneous veins described for the nepheline syenite. However, what little evidence we have seems to point to the quartz syenites as being younger than the true syenites, thus placing them in the same relative position as Brögger's nordmarkites. As for the granites, as has been stated, no age relations were noted, but it is not improbable that when a more detailed investigation of the region is made it will be found that they, too, hold a corresponding position to Brögger's granites and granitites.

However, the evidence collected appears to support the theory that the syenite massif fades into the more acid rocks to the north without any sharp line of demarcation. While, therefore, the age relationships of the various rock types of this petrological province seems to closely follow similar relations in the south Norway region, yet there is reason to think that the whole syenite massif merely represents a peripheral differentiation phase of the fundamental gneiss found to the north. The writer is constrained to this opinion not only by what was seen in the Pic river country, but also by the general appearance and nature of the feldspar in the associate granites which so closely resemble the feldspars of the syenites, as well as the fact that in the northern part of the area visited quartz occurs in both the hornblende and augite syenites much more frequently than in the southern part of the area.

In many of the nepheline syenite areas of the world limestones, or rock containing considerable quantities of lime, are found associated with them. This has led Prof. Daly of the Massachusetts Institute of Technology to formulate a theory which accounts for the presence of nepheline syenites on the assumption that large quantities of limestone were absorbed in the molten magma and conditions developed which made the solidification of nepheline syenite possible.[16]. As far as the Port Coldwell area is concerned, no limestone rocks of any type were found associated with these syenites, so that if Prof. Daly's theory holds, any remnants of such rock must have been carried away by the ice during the glacial period. The only calcium carbonate found in any of the rock occurs as a minor constituent in the rocks themselves, as given in the description which fills the foregoing pages.

[16] See Prof. Daly's paper, read before the Geological Section of the American Association for the Advancement of Science, at Cambridge, Mass., 1909.

Economic Value of the Port Coldwell Rocks

It has been shown by J. Francis Williams that certain of the nepheline syenites and associated rocks of Arkansas are very valuable for building purposes, both because of their durability and their appearance. Many very fine structures have been erected with the so-called blue granite (pulaskite) and other rocks found in the Fourche mountains. Extensive tests were made with those rocks under the direction of Mr. Williams, which proved that they compared favorably for building purposes with the best granites and syenites from any part of the world.[17]

One of the most beautiful rocks in the world for monumental purposes, and for facings of public buildings, is the famous laurvikite of Norway. Large quantities of these rocks are shipped annually to the British Isles, and different countries on the Continent for those purposes. It is also exported to Canada and the United States for monumental purposes.

Bridge over the Little Pic river. The abutments are constructed largely of laurvikite.

There is no doubt that some of the varieties of rock found in the Port Coldwell district would lend themselves admirably to similar purposes. This is particularly true of the dark laurvikite, which occurs so extensively in the neighborhood of Peninsula.

As stated before, most of the rock seen was finer textured than the Norwegian laurvikite, which is used for commercial purposes, yet it is very probable that more extensive explorations would disclose areas of a much coarser rock, which would perhaps be more readily marketable, but even the finer-grained types of this rock would make excellent building material. The dark color of the more typical rock, together with the marked porphyritic development of the feldspars and their dark bluish schiller, gives it great possibilities for the future. The fact that it occurs so close to the lake, and that Peninsula Harbor is perhaps one of the best harbors on that part of the north shore, should make the problem of transportation to the large centres a comparatively simple one.

[17] *Vide* Annual Report of the Geological Survey of Arkansas for 1890, Vol. II.

The C.P.R. have a quarry just a little west of Peninsula from which they have taken a considerable amount of this rock for building abutments for bridges. In the construction of the bridge over Little Pic river, rock from this quarry was used.

Besides the laurvikites, there are certain types of the nepheline rock which would also supply splendid building material. Much of this rock containing the orange red spots of hydronepheline spreustein would supply excellent decorative material, particularly for inter-mural purposes. The light colored nepheline syenites occupying the high hill on Pic island should also find a ready market in the future, and indeed almost every type of rock in the region, including the red syenite and some of the quartz syenites, should prove a valuable asset for the district.

In the neighborhood of Port Coldwell is a rather excellent type of red syenite. An attempt has apparently been made to quarry this rock just back of the little fishing village and between the C.P.R. tracks and the bay.

It might require some searching to locate sections of any of these rocks well adapted for quarrying, but no doubt judicious exploration would result in finding many such places in the area described.

End of Part I.

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